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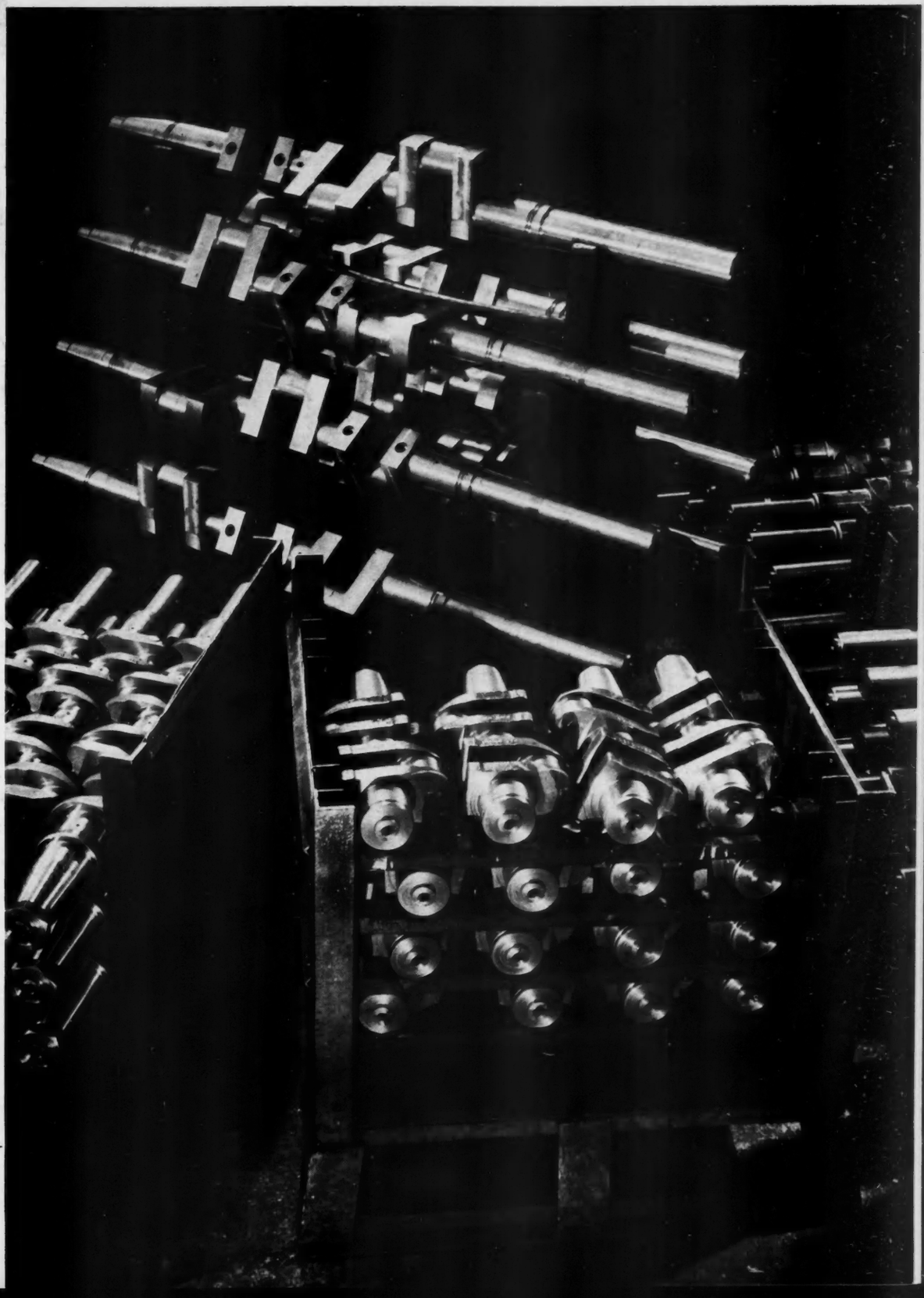

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ENGINEERING

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How Much Money to Burn?

In a few weeks the committee set up by the Organisation for European Economic Cooperation to inquire into the question of European energy resources will present its report. Meanwhile in Britain the debate on coal, oil and nuclear power continues. Oil, like coal threatens to submerge us. The nuclear power programme is thought by some to be redundant. Gluts mean waste. And waste is the product of miscalculation.

The forecasting methods employed by the power industry have long been suspect. For ten years after the war it was confidently assumed that power demand would continue to rise exponentially, at least in the foreseeable future. Though it was clear that in the long term an exponential curve must lead inevitably and with increasing haste towards infinity, and hence must sometime prove invalid, no one apparently supposed that the onset of invalidity might come sooner rather than later.

Unforeseen events may upset even the most painstaking calculations. But if no pains are taken, the forecast will in any case be void. Data must be carefully assembled, duly weighted, analysed and processed, if necessary by computer. But they must first be made readily available. While Chancellor of the Exchequer, Mr. Harold Macmillan complained of the uncertainty in basing one's movements on "last year's Bradshaw." Statistics are indispensable to the modern state—not only in financial but also in technical affairs. What major company could safely manage without an intelligence department? How much more hazardous is lack of working data to a nation.

The Government are not in favour of a "national fuel policy," believing that intervention could only be to favour one fuel industry as against another: the problem of apportioning shares to different fuels is too complex, they believe, to be treated by any other procedure than the market system. Yet the State cannot help but throw its shadow on the market place: tariffs, hidden subsidies, the State's place as purchaser of power stations and railway locomotives, and its influence on investment inevitably create an artificial situation. Indeed, the nation owns three branches of the power industry and virtually controls a fourth.

Abdicating responsibility for planning is certainly no worse than planning in total disregard of facts. Equally futile would it be to plan in the interests of a single industrial group—the miners—as the Labour Party seem inclined to do. Planning has become an uncharitable word, and certainly anathema to many supporters of the present Government. But what industrial concern would fail to plan its operations? The Government, with some wisdom, clearly believe that the centre of gravity of decision making should be at industrial level. Yet whoever makes decisions, whoever does the planning must have a comprehensive source of information. Planning may simply mean the provision of such information.

Knowledge of the future may stem from knowledge of past error. Where have we gone wrong in power planning? Too much coal may not mean too much production but too few consumers. Mr. Richard Wood, the Minister of Power, has admitted that industrial expansion has not taken place at the anticipated rate. Have Government fiscal meaures perhaps over-limited industrial investment? Then, have we taken due account of increasing fuel efficiency: making better calorific use of any given fuel is bound to cut the fuel requirement. When we consider burning coal and oil do we compare the most modern plant in both cases? Has the growth of coal and oil production been artificially stimulated by the threat of nuclear power? Are we aware of the importance of conserving that valuable mobile fuel, oil, by putting coal to better use? Have we spent adequately on coal research to this end?

Mistakes can be so much more expensive than the cost of finding out. There are at present 36 million tons of coal in stock. Putting coal to stock for one year costs £1 per ton and 4*s* a ton for each succeeding year. Apart from waste and insufficient data, the power industry is at present beset by indecision. The atomic power concerns are hamstrung by uncertainty as to the course of nuclear development. The small power reactor cannot go ahead until a ministerial decision has been taken on the choice of ship reactor. The Atomic Energy Authority appears to be in limbo. Silence has met the Electricity Board's appeal for an answer on the Sizewell nuclear station. Coal Board and oil company planning cannot be undertaken unless a decisive lead is given, if not decisive intervention. We have adopted a lively attitude to transport; cannot we be similarly determined in the power industries, where development has an equally long period of gestation and the market response is likewise sluggish.

There is one consolation. Britain is a nation dependent on her industry; and industry depends on energy resources. The situation may change as surprisingly towards shortage, as recently it has moved towards excess. Better to have too much than be crippled by a vulnerable too little.

Cover Picture.—*Two, three and four-throw crankshafts in pallets specially designed for each type of crankshaft.*

(*Nurnberg photograph for* ENGINEERING)

Plain Words

Some people sell their souls, but among engineers and scientists the common practice is to sell your brain. Sell it to the highest bidder. In fact, put it up for auction several times in your life to see if you can become as valuable as a French Impressionist picture. Few of us do.

Renoir's " Les Parapluies " may be worth the latest estimate (£250,000), but very few brains—even the finest brains tuned to high performance by a scientific or technical education—achieve that value. Yet men continue to sell their brains; and get quite cross if the world seems to undervalue them. Contrast this attitude with the attitude of a man who as a schoolboy had no head for examinations, but who has a reasonable measure of common sense and native wit, and a strong will to survive. Because the ready-made jobs are barred to him he creates a job for himself.

He starts a shop or some other small business, and works hard to develop it. If he is shrewd and lucky, and overcomes the first obstacles, he gains confidence as he succeeds. An urge to prove that the schoolmasters were wrong spurs him on. He always felt they were wrong, but all the evidence seemed to be on their side. Now his belief is vindicated: examinations signified nothing. They may have been a gratifying game between the masters and those boys who gained a high place in the term results, but they bore no relationship to real life—the life of earning your place in the world.

Such is the progress of the boy whom the educational system spurned. In the fullness of time he is eminent in commerce or politics. When he is asked to present the prizes at his old school, his little joke about never having taken a prize himself is thought to be typical of VIP prize-givers who are incapable of preparing a cliché-free speech. He alone knows that his joke is serious. Then why does he smile? Because he relishes, with a wry humour, the thought that he is supporting and bolstering the very examination system which he scorned.

As a profession, engineering is particularly open to the danger that its members fail to develop the whole personality. Accountants, for example, generally do develop in this way because they have to impress potential clients favourably, and because they have to build or maintain their own businesses. Engineers, on the other hand, are educated on the notion that a good brain is the sole essential requirement.

Yes, every man is a debtor to his profession, but if he is an engineer or scientist he may be blinded by his own professional qualifications.

CAPRICORN

Weekly Survey

Increasing Anglo-German Trade

Following the success of the Anglo-German trade drive begun a year ago, renewed efforts are now being made to continue the expansion in trade between the two countries.

The figures show that for the first nine months of this year West German imports from Britain have been at the annual rate of £125 million, 21 per cent higher than the figure for 1958. West German imports from two industries, which last year received special attention, are significant. Imports of British machine tools are up by 86 per cent and of toys by 31 per cent. German exports to Britain are not lagging behind. Up to November German imports from Britain this year were worth DM1,187 million while German exports to the United Kingdom were slightly ahead at DM1,196 million.

The economic minister at the British embassy in Bonn has sent personal letters to the heads of 500 firms in Britain outlining the possibilities of the West German market and asking them either to go and see for themselves or send out someone to see for them. The firms written to include manufacturers of carpets, sports goods, toilet preparations, mechanical handling equipment, automatic vending machines, domestic electrical appliances, refrigerating machinery, portable electric power tools, printing machinery, scientific instruments and cine equipment.

There is to be greater British participation, including that by the Board of Trade, at next year's International Furniture Fair, Cologne; the International Toy Fair, Nuremberg; the International Household Goods and Hardware Fair, Cologne; and Interpack at Dusseldorf.

An Anglo-German Trade Council, whose name is not yet decided, is being set up with the object of bringing together executives of West German firms, and executives, whether British or German, of British firms or subsidiaries employed in West Germany.

Help and Self-Help

Sir Leslie Rowan, finance director of Vickers Limited, is to lead the Federation of British Industries' standing committee for policy on under-developed countries.

The FBI's president, Mr. W. H. McFadzean, has explained that the committee is intended to guide industry in the thinking its leaders should be doing on this subject. Mr. McFadzean accepting that it is a widely held view that helping the under-developed is a long-term form of self-help, went on to point out that there are bound to be many difficult short-term problems of adjustment.

Speaking " as an industrialist " he recalled the traditional part played by private capital in overseas investment and urged that we should help the under-developed nations to earn what they want and not to ask for it.

Already some of the older industries were facing competition from developing countries and others may soon be doing so. It was not too early for the Government and industry to be considering what impact this will have on the British economy and how best to make the necessary adjustments.

Between the rapid economic movement of Europe and the resurgence of countries further afield, British industry, not only the president of the FBI and his colleagues but those in the trade unions, stands in a position where decisions that may be critical cannot be avoided.

Future trade with African and Asian countries, once they have achieved average incomes that are to any degree above the subsistence level, is likely, out of the ability to pay and neglecting more complex factors, to be greater rather than less, though not on the same pattern as at present. In this connection it is worth recalling that the European Common Market nations have ideas about helping these nations. And that the early hand-up from poverty is liable to remain as the hand of friendship, both in trade and politics.

Another German Giant

German competition in the motor car markets will be greatly strengthened if a meeting on 9 December of the shareholders in the BMW concern decide as they are expected to, in favour of amalgamation with Daimler-Benz.

Such a combination of present capacity and future financial strength would produce a motor firm of world significance and second only in Europe to the British Motor Corporation. Combined production figures of Daimler-Benz and BMW in 1958, counting in subsidiaries, amounted to 204,514 cars and 58,598 buses and commercial vehicles.

Discrimination against Britain in the European Common Market has long been forecast by Sir Leonard Lord and others. A BMW-Daimler-Benz tie-up would provide intensified competition of the direct quality, and length of production-run kind, unrelated to barriers and quotas.

The key figure in this story is Herr Friedrich Flick, who is 76. In addition to his 40 per cent holding in Daimler-Benz he has substantial stocks in steel concerns in France and Belgium, and 25 per cent of the Dynamit-Nobel chemicals firm.

It is a reasonable assumption that the officials who drew up the schemes for compulsory deconcentration of German industrial holdings, with so little effect on the Krupp empire, had not the slightest idea that the forces they released by making Herr Flick sell his coal holdings, set off the chain of events leading to the fateful meeting of next Wednesday.

Scooters for Slavs

Economic beliefs in Yugoslavia differ notably from those held in her sister Communist states but the level of self-criticism evidently runs at the same high rate.

M. M. Todorovich, Yugoslav secretary of state for economic affairs, has been pointing out in Zagreb that although production in his country has accelerated from the 6·9 per cent annual increase of the years 1953-56 to 11·9 per cent in the past three years, this was almost entirely due to increased numbers in employment. There was a great need to increase productivity, said the minister, and to this end the expenditure of part of the national income on consumer goods was sometimes the best form of investment for the economy. Before the advent of Mr. Khrushchev this would certainly have brought a wintry blast from the Stalinists over the frontier. Implementing their belief that a larger carrot inspires greater efforts, the Yugoslavs have devoted the capacity of a number of plants to this end, including the Tomos plant in Slovenia, now turning out 18,000 mopeds and 2,000 scooters and motor-cycles a year. By 1963 it is expected to have these rates up fourfold in the mopeds and tenfold in scooters and motor-cycles.

Writing in the Russian Army paper *Red Star* the Soviet machine tool expert, Professor T. Zolotarov, complains at the amount of work still being done by hand in Russia. Apart from the millions labouring in agriculture, Professor Zolotarov writes that 100,000 workers still switch rail points manually, 600,000 sew by hand in the clothing industry, and two million

Russians are engaged on loading and unloading by hand.

It is nonsense, Professor Zolotarov writes, that it takes ten times as long to check the accuracy of threaded parts as it does to make them.

On the credit side Zolotarov claims that the first programme controlled metallurgical combine with complete automation is being built and 150 pilot plants similar to it will be completed over the next seven years.

The professor wanted the greatest possible switch to automation with machines based on the most recent developments in electronics, super-conductivity, semi-conductors, radioactive isotopes and new energy resources.

It is a pity that when Professor Melman made his criticisms he was heard only by the tiny audience of the BBC's Third Programme. Professor Zolotarov was able to hold forth to the readers of a Russian daily paper that comes only behind *Pravda* and *Isvestia* in circulation and importance.

Machine Tool Matters

The efforts of the Machine Tool Trades Association to reduce the duty on machine tools has been rewarded with a cut in the tax from 17½ per cent to 10 per cent and the ending of the system of handing back the duty in certain cases.

The handing back applied only where a machine tool user could convince the authorities that nowhere in the home market could he buy the machine he needed at the right time.

Now that the change has been made an Association spokesman, speaking to ENGINEERING, explained that they regarded the step as healthy in returning to more normal trading conditions, allowing users to show in their buying exactly what they wanted, and assisting in combating any impression that the industry was protected.

Although the quota, where it applies, will continue, it is now expected that the main difference to be seen will be an increase in the competitiveness of prices. Since the middle of the year imports of machine tools into this country have been growing and at the same time the order situation at home is widely reported to be better.

Home machine tool makers are likely to be happiest at the removal of the handing back system, for it was this, more than the precise level of the tariff, which in the past led to bad feeling.

While the echoes of Professor Melman's Third Programme BBC talk still rumbled around the machine tool trade the Association replied on the air on 2 December. Professor Seymour Melman, associate professor of industrial and management engineering at Columbia University, warned that "the commercial victory of the Soviet machine tool industry on the world market, including the penetration of western markets, could measurably contribute to a world wide economic and political victory for the Soviet system.

That the Soviet Union was the only place in the world where machine tools were being mass produced was seen by Professor Melman as an event of the greatest significance. In the West there had been failures in industrial organisation and in the technological efficiency of the machinery producing industries.

Professor Melman held out as being necessary targets of a size requiring the sort of energy and common direction usually seen only in war time —several hundred per cent increase in productivity and price reductions of at least 33 per cent in Europe and 50 per cent in the United States.

Even professors may slip and it may have been that for productivity he meant production.

It is certainly a matter for serious reflection that, according to the professor, it is only in the Soviet Union that the recommendations of the 1953 Anglo-American Council on Productivity in favour of reorganising the British machine tool trade to bring in mass production, and Professor Melman's parallel report to the European Productivity Agency a month ago, are being applied.

It is not infrequently heard around the British industry that Western machine tool makers can and do make any tool a customer cares to pay for, while the Russians turn out numbers of a standard product confronting the customer with little choice. In terms of sales within highly developed areas this has point but in Africa, India, China, South America and perhaps parts of Europe the demand may well be for some tools at a price that can be paid rather than a great variety at prices that cannot.

Diamond Developments

Early industrial developments from De Beers' successful following of the General Electric Company of America in making diamonds in the laboratory are not expected. Against the background of a shortage of diamonds over many years the two companies' achievements are presumably going in the future to bring abrasive tools made with "diamond grit" into wider use but the emphasis here is on the future.

More immediately it is suggested from South Africa that what De Beers have done is to arm themselves with the means to compete with General Electric of America should a price war break out in industrial diamonds. The American company's chemists have the advantage of a lengthy start on De Beers and nothing is known of its possible progress towards economical production.

The De Beers team of three scientists and an engineer began work three years ago in Johannesburg and first produced a genuine synthetic diamond measuring a fraction of a millimetre across. The three chief assistants of the research team, led by Dr. J. F. Clusters, a Dutchman, were educated at the universities of Cambridge, Sheffield and Reading.

Mr. Harry Oppenheimer, chairman of De Beers Consolidated, has said that the company has applied for patents almost everywhere, even in the United States.

Submarines to Air Traffic

The terms of reference of the Air Traffic Control Board, announced by Mr. Duncan Sandys, Minister of Aviation, are broad enough to cover the whole of this increasingly complex field and allow for keeping the Minister informed as problems crop up.

The five points of the board's references as a policy making and coordinating body, are:

Formulation of air traffic control policy for the United Kingdom.

Co-ordination of the presentation of UK air traffic control policy in negotiations with other countries and ICAO.

Co-ordination of the work of all authorities in the UK concerned with air traffic control and resolving differences.

Submitting periodic reports to Ministers on the development of air traffic control and seeking Ministerial direction as necessary on particular issues.

Directing the work of the Air Traffic Control Executive.

The chairman of the new board will be 65 year-old Sir Frederick Brundrett, who was deputy scientific adviser to the Ministry of Defence from 1950 to 1954. He has been scientific adviser to the Ministry of Defence and chairman of the Defence Research Policy Committee since 1954. Sir Frederick has also been honorary scientific adviser to the Ministry of Civil Aviation since 1953 and chairman of the Civil Aviation Radio Advisory Committee since last year.

Early in his career Sir Frederick was concerned with research work on underwater communications with submarines.

Letters to the Editor

SCIENCE TEACHING DILEMMA

SIR, I was interested to read your Plain Words of last week.

I think most of us would agree with the first half of Capricorn's views, and we are at present engaged on a new syllabus on science for schools. This will involve the introduction of a great deal of material at present left to the university stage and the exclusion of a good deal of matter at present included in school courses. Most of the new material will not involve mathematics beyond that required at "O" level for the General Certificate of Education.

Where I should quarrel with the comment is in the attitude both of "the man who had an answer" and of the writer, who seem to regard boys' minds as containers to be filled with facts: "schoolboys' minds could retain far more than they are taught at present"; "Schoolboys . . . can learn many more facts than they do at present."

I think that we science masters regard the understanding of principles and the ability to apply them to new problems as much more important. It is of course important to build up a sufficient background of factual knowledge to enable one to discuss and apply principles. "Science is an adventure of the human mind" and boys should be brought to comprehend such of the major generalisations which are both landmarks in the advance of scientific knowledge and relevant at the present time.

We would agree that all teaching should start from observed phenomena, but theoretical concepts should be introduced when the need for them arises and when some reasoned explanation based on observation can be given.

Without theoretical concepts, chemistry would become merely a "cookery book" study, and physics a list of unrelated phenomena. Moreover, from the merely practical point of view of learning facts, it is much easier to learn facts when they are understood and fit into a comprehensible pattern of knowledge.

I am not sure about the "prodigious memories of schoolboys." My impression is that the ability to learn by heart is considerable over the age range 8 to 12 years, but that it decreases fairly rapidly after this. I am not sure what the findings of educational psychologists are on this point, but I think that the ability is connected closely with the interest of the child in the subject matter, and the younger child seems to find interest in facts associated with his environment even if they are disconnected. The older child is more satisfied with a connected pattern—hence the need for theoretical concepts.

Yours sincerely,

H. F. BROAD,

Hon. General Secretary.

The Science Masters' Association,
The Cedars School, Leighton Buzzard.
30 November, 1959.

SIR, If Capricorn's luncheon partner thinks that the assimilation of unrelated facts can be called a scientific education we may consider ourselves lucky that he is becoming head of a technical college rather than a secondary school. He will do less damage. To teach schoolchildren phenomena—what happens when an electric current passes through a conductor—without attempting to explain the phenomenon on a higher level than the observation is comparable to Pavlov's method of teaching dogs: if the bell rings, food will follow. A child so trained will be capable of narrating a vast number of unrelated facts on demand, but without the slightest ability to compare, classify and deduce: that is, to think. His conclusions, if any, will be as fallacious as those of Pavlov's dogs. The method suggested is unsound, unscientific and, in fact, uneducational. Coming from a scientist, this is the more surprising as education turned into a large-scale mnemonic exercise is not likely to produce capable scientists.

A similar approach had been attempted in

Continued on the next page

America following the appearance of John Dewey's philosophical works. Based on the *a priori* statement that education is a social function, Dewey suggested that the teaching of facts should be related to the student's physical and social environment. Dewey thought that facts presented in terms of the environment would make a positive contribution to the student's education as a member of society over and above the mere assimilation of knowledge.

When put into practice, the unfortunate result was an education from which the logical relationship of physical phenomena did not become apparent; it was descriptive and disjointed. In all fairness to Dewey, he neither desired not foresaw the consequences. The unscientific nature of the education was a consequence, not of the implementation of Dewey's philosophy, but the attempt to teach in terms of phenomena, without emphasising their interdependence. Many Americans now consider the system a failure.

The solution to an overburdened syllabus—the result of the rapidly expanding scientific universe—is not to make up memory aids, but to eliminate all fact that is not necessary for the demonstration of the underlying abstract principles. "Richard Of York Gained Battles In Vain" can be used to teach the colours of the light spectrum (red, orange, yellow, green, blue, indigo and violet), but is it necessary or worth the trouble? It is far better to teach the principle of refraction and the electromagnetic wave theory; if the student is sufficiently interested in the colours of a rainbow let him take a prism and see for himself, instead of relying on memory. Scientific advances are not made by lexicographers, who have all the facts, but by scientists who find out how the facts fit together.

Yours very truly,

B. M. ALDEN.

4 Hayburn Way, Hornchurch, Essex.
29 November, 1959.

INFORMATION OFFICERS OR LIBRARIANS?

SIR, Before discussing the matter I should aplogise for my poor English. It was with much interest that I have read Miss I. M. Slade's article, and I think that ENGINEERING is to be congratulated on having opened its columns to this important and topical problem. ("Let the Information Officer Inform," ENGNG., 23 Oct.'59, p, 374).

Many of your readers should be thankful to the author for presenting this problem: management people, scientists, engineers, and so on, as the potential users of information work; information officers themselves looking forward to better understanding; and last, but not least, librarians, in view of better cooperation with their recent colleagues, the "information officers."

Thus, one might have expected an objective and cool-headed discussion of the matter. But, apart from Mr. H. D. Barry's relevant and objective letter bringing up to date Miss Slade's statement on the Library Association's examinations (ENGNG., 13 Nov.'59, p. 463), there was only a rather negative echo from a valiant phalanx of librarians, containing statements suggesting some lack both of clear sight and tact. Defence against fulminations such as "parrot-like repeated comments" and a judgment of this way of argument may be left to Miss Slade and your readers, respectively. But it is at least very doubtful whether it is not your librarian correspondents who are "under the false impression" (by identifying the information officer with the librarian).

When will a minority of librarians eventually realise that something new and different has come up with the information officer? Why that constant claim for competence for special requirements which nobody reasonably can, and will, lay upon the librarian? With a full esteem of librarianship and its great achievements, no information officer of practical experience will pretend to be competent in librarianship (unless he has the respective special training). So, in turn, it would be but fair, if the librarian would esteem his information colleague likewise, correcting that untenable standpoint to be automatically an information officer in a particular field.

That latter activity requires some extra qualifications quite different from those of a librarian, and in addition to those which librarians and information officers may well have in common. These "extras" cannot be acquired by some special lectures supplemented to a librarianship course. This would mean an unrealistic and dangerous underestimation of science and technology, and their branches. These extras rather have their sound basis in extensive studies, possibly with graduation, and practical work in the particular field to be covered by the information officer, such as chemistry, metallurgy, mechanical or electrical engineering, to quote a few only.

Take, for instance, the technical information service in a mechanical engineering firm. Surely the librarian who runs its library may well provide, to some extent, a lot of information. But how can he run that continuous information service which means screening the flood of incoming periodical and similar literature, separating the essential material from that to be rejected, abstracting if necessary, storing for easy retrieval, informing the persons really concerned, and so forth, if he has not a working knowledge of the broad field ranging from production techniques to underlying principles, functions, applications, and the latest design trends of machines and apparatus?

I hope these examples will demonstrate where there is the specific challenge to the information officer; a challenge he, in general, cannot answer satisfactorily without the proven help of a well-run library, that is, of a librarian. This assistance relation is a mutual one: librarian and information officer, each completing the other (a must in our age of the "division of labour"), are performing "team work" in the best sense of that word, and I am happy to have exercised this practice for years; cooperating as technical information officer with my librarian colleague in an industrial concern. Other concerns in this country are following a similar practice, and this policy, which I think is a sound proof that the information officer is indeed something other than a librarian, is surely based on rational thinking.

It is in the well-tuned cooperation between librarian and information officer that I see great chances and promising perspectives for their common task: information work. Referring to the title in your Letters column, I should like to say: Information Officers *and* Librarians.

Sincerely yours,

W. SONTAG,
Technical Information Officer.

8 Klingenberger-Strasse,
Mannheim-Wallstadt, Germany.
22 November, 1959.

SCIENCE MUSEUM'S EXHIBITS

SIR, In the enjoyable article on "Aeronautical Exhibits at Science Museum" (ENGNG., 30 Oct.'59, p. 408), your writer rightly remarks on the educational role of the museum in stimaluting the public's interest in science and its importance as a permanent technical exhibition for British industry. May I amplify his comments a little? Interesting though the Science Museum is, its work is surely hampered at present by the arbitrary arrangement of exhibits with quite different functions. In my view, the museum now has three distinct roles (apart from its library):

(1) As a museum of historical scientific and technical exhibits.

(2) As an educational centre, to provide for the lay public simple visual explanations of scientific principles by diagrams, models, working apparatus, etc. (This was, indeed, its original role.)

(3) As a technical exhibition, to provide for the lay public and the specialised scientist and technologist, a glimpse of modern industrial practice in the principal branches of technology.

Ideally, the exhibits relevant to these roles should be sited in three separate groups in each gallery, although the more fundamental exhibits under 2 could well be grouped together in an Educational Gallery (some of the models in the present Children's Gallery would certainly be appropriate to this). Role 3 implies a changing set of exhibits, and this would require much help from industry; a few of the exhibits replaced as being out-of-date would find their way into the permanent historical sections.

Ever since the museum began over a hundred years ago, British Governments have given it insufficient resources to do its job properly. Implementing my suggestions would cost a large sum and require a bigger staff than the Science Museum is at present allowed. But I believe this segregation of functions to be important if the museum is to be effective in making the British public more interested in science and technology.

A historical approach to learning science must often be confusing for the layman, and at present many of the museum's galleries, good as they are in their own way, are calculated to bewilder anyone who seeks information about either relevant scientific principles or present industrial technical practice. Lord Hailsham in his campaign to make Britain more science minded should find funds to expand and publicise the Science Museum. In its early days the museum's exhibits were known as the "Educational Collection," and, although this function has never been wholly dropped, there is now a big opportunity for its development as something contributing to the future well-being of Britain.

Yours sincerely,

CHRISTOPHER T. RIVINGTON,
Scientific Editor.

Blackie and Son Limited, London, WC2.
27 November, 1959.

LEARNING CONCRETE SKILLS

SIR, The suggestion in the note entitled "Bridge Design and the Road Programme" (ENGNG., 13 Nov. '59, p. 475) that lack of experience in prestressed construction might have been an adequate reason for not using this technique for the bridges over the London-Birmingham motorway, while charitable in its intent, does not really bear examination. Even assuming that sufficient labour having previous experience of prestressed work could not have been assembled, and even this seems doubtful, there is reason to believe that most good quality constructional labour can pick up the necessary skills very rapidly.

Some ten years ago, when prestressed construction was very much in its infancy in this country, we constructed in Southampton Docks a small foot bridge of about 70 ft span consisting of two post-tensioned girders made up of about 12 precast units each. The assembly and prestressing of these units on the Freyssinet system (five cables to each girder) were carried out by the permanent building labour force of the Docks using hired equipment. In view of our unfamiliarity with the work and the fact that it is always the unknown that terrifies, we allowed two days for the prestressing operation. In the end, although we made a late start on the first day, we finished by lunch time on the second day.

A few years later we had a similar experience constructing precast roof members for a shunting locomotive shed using, this time, the Lee-McCall system. In neither case did either the labour employed or their supervisors have the slightest difficulty in understanding what it was they were doing and how they were supposed to do it.

Yours faithfully,

J. H. JELLETT,
Chief Docks Engineer.

Southampton Docks.
26 November, 1959.

TEMPERATURE ALARM
High or Low

DESIGNED to give audible or visible warning of temperature changes, the Tempo-O-Larm is intended primarily for use with refrigeration equipment such as frozen food cabinets or cold storage vaults.

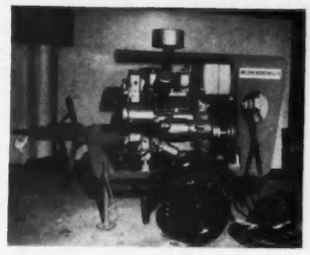
The unit is capable of sensing high or low temperatures in any type of processing equipment where it is possible to fit a thermostat. Basically the system consists of a small temperature detector which is placed in the section to be monitored and connected by wires to an annunciator located where the warning can be most easily heard or seen. Each annunciator unit can be removed or installed by disconnecting the plugs and aligning the couplings. No internal wiring or connections have to be altered.

A rise in temperature in the space being monitored above that at which the device is set starts the alarm. To compensate for the normal changes which result from defrosting cycles or reloading a cabinet there is an adjustable automatic control which can be set to delay the alarm for up to six hours and so prevent false alarms.

Two standard supply units of 240V 50 cycles are available to supply from one to six or from seven to twelve separate annunciator units. Each unit controls a particular area. It is also possible for one unit to be used for more than one space provided that the temperatures of the spaces are within 10 per cent of one another and that the defrosting cycles take place at the same time; thermostats must be connected in series.

In addition to detecting temperature changes the unit can be used to give an indication of loss of refrigerant, faulty thermostat or faulty expansion valves. If a complete power failure occurs instant warning is given. *The Walter Kidde Company Limited, Bellvue Road, Northolt, Greenford, Middlesex.*

MOBILE WELDER
Alternating Current



NEW to the Weldwell range is a lightweight inexpensive mobile welding set using alternating current.

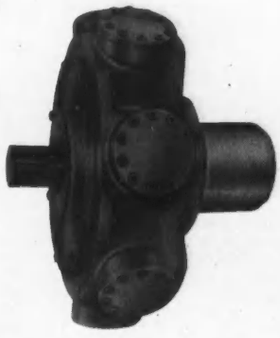
Particular claims are that the plant costs only about two-thirds the price of a d.c. plant and that it only weighs about one-half the amount of a conventional plant of equal output. As there is no magnetic arc blow the welding characteristics are good. The arc is elastic and the striking qualities are unaffected by the current setting. Fine switching maintains current control.

The alternator runs at 3,000 r.p.m. for a frequency of 450 cycles and has an output of 20 to 250A. This enables electrodes from 16 to 4 s.w.g. to be used. A power take-off is included enabling a grinding disc to be used running from a flexible shaft. Power is supplied by a Petter PC3 air cooled diesel engine developing 15 h.p. at 3,000 r.p.m.

Engine and alternator are mounted on a frame with a sheet steel shroud for weather protection. When supplied for hand towing the equipment weighs approximately 780 lb and when arranged for static use it weighs 750 lb. Mounted on a high-speed chassis as shown the weight is increased to 855 lb, which is still low. Overall dimensions are: length 6 ft 4 in; height 4 ft 2 in; and width 3 ft 5 in. The length includes the tow bar. Independent rubber suspension is used for mounting the unit on the chassis. The tow bar incorporates an overrun brake and a hand brake is also fitted.

It is also claimed that as there are no commutators, slip rings, or brushes the amount of maintenance is reduced to a minimum. *Welding Industries Limited, Blackswarth Road, Bristol 5.*

HYDRAULIC MOTOR
Slow Speed
High Torque



AN ADDITION to the range of Staffa hydraulic motors is the Mark V model shown in the illustration.

This is a slow speed high torque model with seven radial cylinders. Each cylinder has a bore and stroke of 4 in and 3 in respectively.

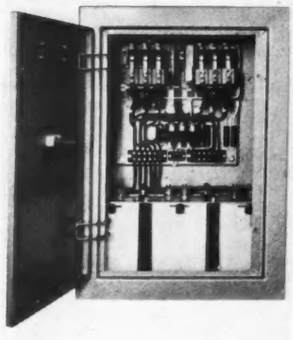
The general design is similar to the existing five cylinder model but the crankcase and the cylinders form a monobloc casting with the seven cylinders arranged radially and fitted with detachable heads.

At the normal hydraulic working pressure of 2,000 lb per sq. in, the manufacturers state that the maximum output torque is 6,650 lb-ft with a corresponding overall efficiency rating of 94·2 per cent.

The speed range is from 0 to 75 r.p.m. and the driving shaft may be safely loaded with six tons overhanging weight. For starting and peak loading the hydraulic pressure can be increased to 3,000 lb per sq. in giving an increased output torque of 10,000 lb-ft.

Like the original five cylinder model, the speed of Mark V is infinitely variable over the stated range and the rotation can be in either direction. Present applications are on dredgers, augers, conveyors, cranes and winches. *Chamberlain Industries Limited, Staffa Works, Argall Avenue, London, E10.*

STARTER
For Squirrel Cage Motors



THE Statormatic starter for squirrel cage motors up to 80 h.p. gives smooth control without the switching peaks inherent in star-delta types.

Other claims are that the equipment is automatic in operation and does not depend on sequence switching operation of series resistances nor is it as expensive as an auto-transformer unit.

Basically the Statormatic is a series resistance type but instead of using metallic elements, the resistance is obtained by a liquid that decreases in resistance as its temperature increases. The reduction is in the ratio of about 5 : 1 over the temperature range used in this application. When the motor has speeded up, a contactor short circuits the liquid cell.

The whole equipment is housed in a sheet metal case for floor or wall mounting according to size, and fitted for local or remote control. The resistance liquid and the electrodes are contained in a moulded polyethylene tank. Time control of the short circuiting contactor is normally carried out by a thermistor on the smaller units, or by a mechanical timer started by the closing of the line contactor on the larger ones. Where frequent operation is required the thermistor may be replaced by a solenoid operated timer. *Lee Guinness Limited, Newtownards, Northern Ireland.*

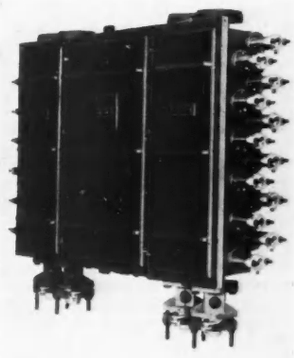
ROOM HUMIDIFIER
Non-Wetting

THE Aerosolette is a portable humidifier for industrial premises.

The unit is powered from the ordinary electric mains and has a consumption of 60 watts. Its evaporation rate is about one pint per hour. It is particularly claimed that the water is completely atomised to such an extent that it is "dry" to a hand held near the outlet. Passage of free air through the unit gives even dispersal of the mist and therefore gives even humidity over the whole room.

Overall dimensions of the unit are 10¼ in high, and 11 in diameter (without the stand shown). The weight is 10 lb. It is finished in stove enamelled silver grey. Optional extra equipment includes time and humidity controls, the stand shown, and a directional cowl for hospital use. Suggested applications are laboratories, paper stores, art galleries, and florist's shops or to combat the effects of central heating. *Aerosol-Turbo Limited, 14 Cross Belgrave Street, Leeds 2.*

CONNECTING BOXES
Flameproof



A NEW range of link type electrical connecting boxes give up to 90 links.

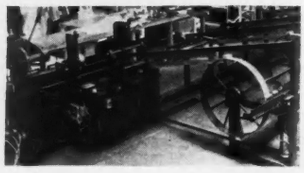
There are four basic sizes of box and seven versions giving 6 links; 15 links; 20, 30, or 45 links; and 60 or 90 links. The dimensions are 14⅞ in by 11 in by 6 in; 14⅞ in by 17½ in by 6 in; 40¾ in by 15¾ in by 6 in and 40¾ in by 31 in by 6 in. All models are certified flameproof for groups I and II gases.

The cases are of mild steel construction. The terminals are brass extruded sections fitted to insulated board, and each terminal is separated by an insulated barrier. Connections are made by surface clamp on cable using a head screw. The cable entries are by brass gland sets for wire armoured cable fitted to the sealing box.

A special point is that the sliding link bars are so constructed that the cable connections are not disturbed when sliding the link clear for testing purposes. Both terminals and links can be numbered to suit the customers requirements for any special application. Internally the boxes are divided into three compartments. The two outer ones are the sealing boxes for the cables coming into and out of the box and the centre one contains the links arranged in groups. *W. and H. Nelson Limited, Nelbest Works, Mossend, Scotland.*

TRANSFER MACHINE

Tube Preparation



HYDRAULIC-PNEUMATIC equipment for preparing condenser tubes from drawn stock has been produced.

The equipment will handle tubes from ½ in to 1 in diameter taking them directly from a reeling machine, checking the tubes for flaws, sawing to length, deburring the ends, blowing swarf clear and feeding the tubes to a stillage.

Thin wall tubes are manually fitted into a reeling machine (not shown) for straightening. As the tubes leave the reeler they slide into a steel channel and a withdrawal arm pulls them clear. The channel is at the lower right of the illustration. The spoked wheels lift the tubes by means of the wooden blocks and allow them to roll down wooden rails to the Teledictor flaw detector. A faulty tube stops the mechanism and a signal lamp lights up. The tubes are fed through by powered rollers.

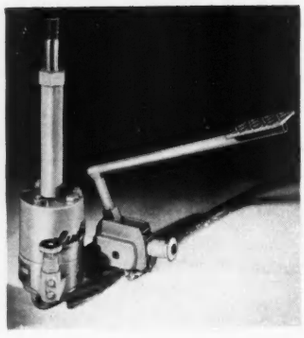
Under normal conditions the tubes pass from the detector into a receiving channel and are then transferred to V-blocks ready for the end sawing operation. Two circular saws, one of which is adjustable along the machine, are arranged to cut both ends simultaneously. As the saw heads move downwards the tubes are automatically clamped by the blocks. Lengths from 5 ft to 30 ft can be cut.

The tubes then pass through a deburring station where both ends are treated. At the last station the swarf is blown clear and the tubes roll on to a waiting stillage.

The equipment is powered by 400-440V 3-phase 50 cycle electrical supply and operated by 70-100 lb per sq. in air supply. The hydraulic and pneumatic circuits are provided with full interlock protection. As supplied, the equipment is operator controlled but it could easily be converted to fully automatic operation. *Hymatic Engineering Company Limited, Redditch, Worcestershire.*

HYDRAULIC RAM

Foot Operated



THE Linford 4000 combined pump and hydraulic ram unit has now been produced in a foot operated version.

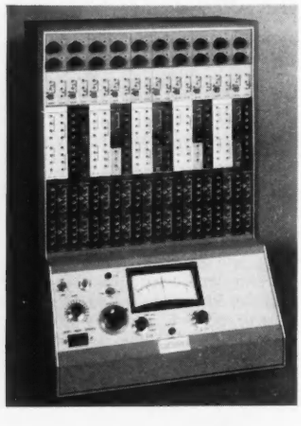
The unit is designed for installation in such equipment as lifting tables, fork trucks or other ram operated items. It is made with five sizes of ram capacity, ranging from 1,100 lb to 4,400 lb thrust. All can be used on the same pump base.

The pump is a single acting two speed (manual change) unit with a built-in relief valve to prevent overloading. The working pressure is 1,500 lb per sq. in. Oil displacement at "slow" speed is 0·700 cu. in per stroke and at "high" speed is 1·106 cu. in. The latter is normally used with light loads. The rates of lift corresponding to the two speeds are 0·891 and 1·400 in per stroke for the 1,100 lb ram; the values are correspondingly reduced for rams of larger size. The pump unit is 4⅜ in diameter and stands 10½ in high. It is mounted on trunnion brackets.

The ram cylinders are made from polished bore hydraulic tubing and the piston rods are treated with hard chromium. The stroke of the ram can be made to suit individual requirements. As no pipe work is required the installation becomes simple and assembly costs are reduced to a minimum. The pedal has a spring return. The incorporation of a second speed allows a quick lift for loads up to about three-quarters of the full load capacity. *Linford Engineering Company Limited, Baker Street, Birmingham 11.*

ANALOGUE COMPUTER

Transistorised



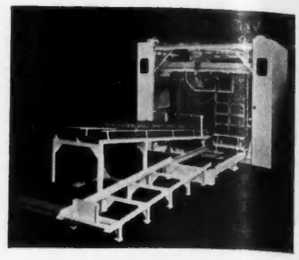
THE Pace TR10 analogue computer is a fully transistorised instrument that measures only 15 in by 17 in by 24 in high.

It is claimed that 95 per cent of routine mathematical design operations can be carried out on it to an accuracy of 0·1 per cent. The standard basic model has ten operational amplifiers and can be expanded to 20 amplifiers and several multipliers, function generators, and other non-linear units. If larger expansion is needed several computers can be connected together.

All the units plug in. At the top are the attenuators; below them the non-linear components, and at the bottom the amplifiers. All controls are on the sloping panel. Since transistors are used there is no warming up period and no cooling problem. The consumption at 115V 60 cycles is less than 60 watts. A push button potentiometer readout system speeds setting up, and a built-in null voltmeter provides direct reading or precision null reading. External equipment available includes an X-Y plotter and a two-channel strip chart recorder. Accessories are feed back and input resistors, diode units, and patch cords. There is also a service shelf for maintenance of units. *Electronic Associates Incorporated, European Division, 43 rue de la Science, Brussels 4, Belgium.*

PALLET LOADER

Straight Line Feed



TO speed up production and to reduce manpower a pallet loading machine has been produced to operate from straight line feed.

The machine, of which there are two versions, was originally developed for moving and stacking bottle crates but has since been adapted for cases and cartons. The first machine is for cases that are not self-interlocking. It will stack up to 30 standard one-dozen 26 oz size cases in five layers of six cases per layer, turning the pallet through 90° after each layer to give full interlocking.

Cases are fed to the loader along a gravity roller conveyor which is arranged to suit individual requirements. A timing device permits only three cases to pass forward at a time. These cases are then lifted and moved on to the pallet which is housed on a revolving turret. The second delivery of three cases is similarly transferred to the pallet and simultaneously a timing device operates turning the turret through 90°. On the original model the cases were placed on the turret by hand and the full pallets removed by fork or pallet truck, but designs are under way for automatic loading and discharge.

The second model differs from the first in that it is designed for interlocking cases and there is no turret. Both machines are pneumatically operated and can be supplied with built-in compressors if required. They will handle up to 1,000 twenty-bottle crates per hour and the rate can be varied to suit conditions. The makers also build units to stack seven layers. *Gimson and Company (Leicester) Limited, Vulcan Road, Leicester.*

MOBILE CRANE

12½ Tons Capacity

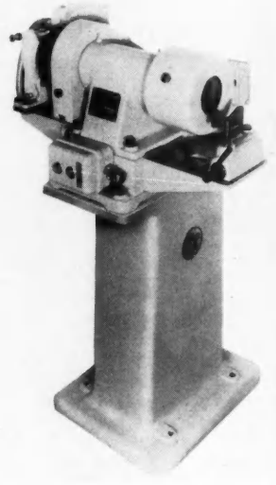
A NEW version of the Jones KL10-10 fast travel mobile crane has been produced with the lifting capacity increased to 12½ tons. It is to be known as the Mk. III.

As in the earlier model the power is supplied by a single prime mover. A double ended cabin houses all the controls and these are designed for operation by one man. The cab has been repositioned on the off side whereas before it was full chassis width. Two driving positions are provided, one facing forward for road travel and the other facing the rear. The latter is equipped with simplified finger tip crane controls together with duplicate travel controls arranged as in standard automotive practice. The crane can be supplied with either a strut or a cantilever jib and the offset cab allows the latter to be lowered on to a bolster to reduce height when travelling.

The load of 12½ tons can be lifted at a radius of 10 ft with the outriggers in place. The maximum free load is 7 tons. Power lowering is standard. Cantilever jibs are available up to 60 ft and strut jibs up to 75 ft. Travelling speed is 30 m.p.h. The engine is a Leyland 0600 water cooled diesel developing 125 h.p. at 1,800 r.p.m. *George Cohen, Sons and Company Limited, Wood Lane, London, W12.*

POLISHING MACHINE

Round Work



A RECENT addition to the Rudkin and Riley range of polishing machines is the hand model 2006/3 illustrated.

The machine has been designed to take a wide range of cylindrical workpieces including such items as wire and tube drawing dies. The standard model is fitted with an adjustable hand rest and an aluminium guard that surrounds the chuck. A push button starter and all electrical gear is included.

Special design features include the use of large taper roller bearings in the spindle; the provision of lubricating points at convenient positions and a sturdy construction. Optional extra equipment comprises electromagnetic brake, low-voltage lighting and a cast stand as shown. Alternatively the machine can be bench mounted.

Chuck sizes up to 7½ in can be fitted and the speeds available are 2,400 and 3,150 r.p.m. for a motor running at 2 850 r.p.m., and 1,200 and 1,575 for a motor speed of 1,425 r.p.m. The machine measures 28 in in length, 33 in from front to back, and is 50 in high. It weighs 420 lb. *Rudkin and Riley Limited, Cyprus Road, Aylestone, Leicester.*

SHIPBUILDING RESPONSIBILITIES

Difficulties arising from the transfer of responsibility for the shipbuilding industry from the Admiralty to the Ministry of Transport were discussed in the House of Commons last week on a motion by Mr. James Callaghan (Labour) to annul the Transfer of Functions (Construction of Ships) Order.

He contended that members were very dubious about the transfer of these functions to a ministry whose record in transport over the past ten years had been nothing short of calamitous. These responsibilities had lain with the Admiralty for over 20 years and whatever complaints there may have been about the Admiralty, there was no doubt that that department had exercised a very watchful eye over the progress of the shipbuilding and ship-repairing industries.

Mr. R. J. Mellish (Labour) said the House knew that hundreds of British ships were laid up. The British shipbuilding industry was in competition with some of the great ship-repairing yards of the world. The Ministry of Transport was already overloaded with work. The problems involved were too great for any one man to deal with. In his own constituency, Bermondsey, London, he had many constituents employed in shipbuilding and ship repairing. The average level of unemployment there was as high as 11 per cent.

MODERNISATION IN THE CLYDE

There were fewer functions now left to the Admiralty than ever before, said Mr. Harry Hynd (Labour), and he wondered what was to be done with the department's big rambling buildings, not only in Whitehall, but in Horse Guards Parade and in other places. What would happen to the offices vacated by the staff, which, presumably, would move? Where would the new staff go and would new offices be taken for it? Unless the Minister handled this matter carefully, there would not be a simple transfer of staff from one department to another, but there would be extra expenditure at the Ministry of Transport and no economies at the Admiralty.

It was pointed out by Mr. Frederick Willey (Labour) that the transfer did not mean that there would now be a coordination of all transport arrangements in the Ministry of Transport because its powers over aviation had been removed and given to the newly-formed Ministry of Aviation. Foreign competition in the shipbuilding industry had become so keen that prices were unrealistic. The essential thing was to hold the industry's labour force. The capacity of the world's shipyards had trebled three times in a few years. Japan was taking every step necessary to maintain her present level of shipbuilding. So was West Germany. The industry felt very much that it had been neglected. In spite of that, a journey to the Wear, the Tyne, the Clyde and elsewhere would show what British shipyards had done in the way of modernisation.

INDUSTRY IN THE DOLDRUMS

It had been stated, said Mr. Ernest Marples, the Minister of Transport, that the Ministry of Transport had a great burden and he agreed. The reasons for the transfer were fairly simple. Before the Prime Minister made the change, the position in civil aviation was that the Minister of Transport had responsibility over the running of the aeronautical services and the Minister of Supply for the production of aircraft. That was a division of responsibility and not really efficient. The Minister of Transport was responsible for running shipping while the Admiralty was doing the licensing for shipbuilding and ship-repair work.

The new Order transferred the responsibility for licensing. The extent of the Admiralty's duties which were being transferred could be judged by the number of civil servants involved—sixteen. The Restriction of the Construction of Ships Order sought to bring under central control during the Second World War the country's shipbuilding resources, both naval and civil. No ship could be built in a United Kingdom shipyard unless its builder held, or obtained, a licence from the Government for the purpose. Licensing had probably been retained because it was the most effective method of ensuring that Britain met the obligation it had accepted to embargo the construction of certain kinds of ships for countries in the Sino-Soviet *bloc*.

He realised that the industries were in a difficult position and in the doldrums for reasons of world trade. Their problems were immense. Within the coming few days he was to meet representatives of the shipbuilding and ship-repairing industries. With all the rationalisation that was going on, the owners and operators of ships should be brought into consultation with the shipbuilders and ship-repairers in the same way as operators of aircraft should be brought into consultation with the constructors of aircraft.

HMS DREADNOUGHT

A short discussion took place respecting the progress being achieved in connection with the construction of new naval vessels. Major P. H. B. Wall (Conservative) asked when the Dreadnought was to be launched, when a sister ship was to be laid down and when it was proposed to commence the construction of a nuclear missile-carrying submarine.

In connection with these matters, Mr. Ian Orr-Ewing, the Civil Lord of the Admiralty, said that it was not the practice to disclose the dates of the launching or commissioning of Her Majesty's ships before they were firmly settled. The Dreadnought would be the first British vessel of this revolutionary type and many very great engineering problems were involved. It would be unwise to forecast at the present stage but he would certainly try to give advance warning of the ship's launching.

On the other points, Mr. Orr-Ewing said that an effort was made to give the country a greater amount of information, and the Admiralty had recently announced when the keels of some new surface ships had been laid down. It would be most unwise to go any further in announcing future plans but it could be stated that work was proceeding at Dounreay on nuclear submarine prototype machinery. He agreed with Major Wall that the building of a sister ship to the Dreadnought would provide valuable operational experience and said that most careful consideration was being given to laying down a second vessel. He felt unable to give an off-the-cuff answer to a suggestion by Major Wall that the missile-carrying submarine might well provide the best deterrent against an enemy, but said that the matter was one of very great strategic and economic importance.

NUCLEAR PROPELLED SHIPS

Dealing with nuclear-propelled vessels generally, Mr. Orr-Ewing said that the possible application of this form of propulsion to surface vessels was being carefully studied at the present time. The Dounreay prototype submarine machinery would be of British construction, but made use of a pressurised water system that was similar to the American type of propulsion unit. The Admiralty had a very close and abiding interest in the nuclear propulsion of a warship. A study-contract had been placed with the Yarrow-Admiralty Research Department and that work was going forward with full Admiralty support.

Later, Dame Irene Ward (Conservative) questioned the Minister of Transport about the fate of the Galbraith Committee which had been set up by the First Lord of the Admiralty to inquire into the marine application of nuclear power; the responsibility for the committee having been transferred to the Ministry of Transport. Mr. Ernest Marples said that the committee had completed their examination of the immediate problems concerning the development of nuclear propulsion for merchant ships and the Government was considering the recommendations. When decisions had been taken, he would consider whether the committee should be reconstituted.

OCCUPATIONAL HEALTH

A request was made to the Minister of Labour by Mr. Laurence Pavitt (Labour-Cooperative) that a medical or health expert should be included among the advisers of United Kingdom delegations to future International Labour Conferences. He suggested that much attention had been given to occupational health services by the International Labour Organisation during recent years and that there was a wealth of specialised knowledge in this field in this country which doctors were anxious should be available to the conferences.

Mr. R. E. Prentice (Labour) pointed out that, this year, the Organisation had passed a recommendation on occupational health services and had asked that the matter should be brought forward again as soon as possible, with a view to a convention being summoned to consider the subject further. The results of this action by the Organisation might well affect legislation in this country. Mr. Edward Heath replied that representations had been received and that the appointment of a medical adviser on the occasion of the proposed convention was being considered. There was, however, a limit to the size of the delegations and to the number of advisers who could be taken with them. The Ministry of Labour had the advantage of their own medical advisers on these occasions.

Officer Entries for Royal Navy

Information about the availability of scholarships at Dartmouth was sought by Mr. John Dugdale (Labour) from the Civil Lord of the Admiralty. He was told by Mr. Ian Orr-Ewing that 96 scholarships were available this year for eventual entry to Dartmouth. There were, however, 696 unsuccessful candidates.

Commonwealth Telephone Cable

Completion of the first stage in the laying of the round-the-world coaxial telephone cable is expected in 1961 and will consist of the section linking the United Kingdom with Canada. Mr. J. R. Bevins, the Postmaster-General, told Mr. John Biggs-Davison (Conservative) that a conference, recently concluded in Sydney, had recommended that the next stage should be the completion by 1964 of a cable linking Canada, New Zealand and Australia. The Government of the United Kingdom expected to reach early conclusions on that proposal and he was confident that other Commonwealth Governments would also reach decisions shortly. He could not yet forecast a timetable for further links.

European Telecommunications Services

Mr. Ronald Russell (Conservative) asked the Postmaster-General about the functions of the newly-formed Conference of European Postal and Telecommunications Services. He was told by Mr. J. R. Bevins that this body was set up following an international meeting of government representatives in Montreux in June last. The Arrangement for forming the Conference was signed by the Administrations of 19 countries, including the United Kingdom. The new body was essentially consultative. Its aims were to exchange views and information and to initiate studies of technical problems of particular concern to Europe. It would concentrate mainly on work of a practical nature to improve the efficiency of the European postal and telecommunications services. The Post Office was taking its full part in the work of the Conference.

Monaco Atomic Energy Conference

A full report of the proceedings of the conference of the International Atomic Energy Agency at Monaco is to be published in due course. Sir David Eccles, the Minister of Education, told Mr. E. G. M. Fletcher (Labour) that they would be lengthly and that it would be some time before the Agency could publish them.

MEETINGS AND PAPERS

Association of Supervising Electrical Engineers

CHESTER
"Application of Electricity in Oil Refining," by S. York. Chester Branch. Westminster Hotel, Chester. Tues., 8 Dec., 7.45 p.m.

British Institution of Radio Engineers

LONDON
"Simulation of Nuclear Reactors and Power Plants," by W. J. G. Cox and J. Dowsing. Computer Group. London School of Hygiene and Tropical Medicine, Keppel Street, WC1. Thurs., 10 Dec., 6.30 p.m.
BIRMINGHAM
"Development of High-Frequency Tape Recording," by P. J. Guy. West Midlands Section. Matthew Boulton Technical College, Suffolk Street, Birmingham. Tues., 8 Dec., 7.15 p.m.
NEWCASTLE UPON TYNE
"Micro Miniaturisation," by H. G. Manfield. North Eastern Section. Institution of Mining and Mechanical Engineers, Neville Hall, Westgate Road, Newcastle upon Tyne. Wed., 9 Dec., 6 p.m.

Chemical Engineering Group

LONDON
"Rocket Propulsion," by J. E. P. Dunning. Tues., 8 Dec., 6 p.m.

Chemical Society

LONDON
"Recent Advances in Fluorocarbon Chemistry," by Professor G. H. Cady. Centenary Lecture. Thurs., 10 Dec., 7.30 p.m.
BRISTOL
"Rockets," by Dr. J. Black. Bristol Branch. Department of Chemistry, The University, Bristol. Thurs., 10 Dec., 5.15 p.m.
NOTTINGHAM
"Study of Knock and Anti-Knock by the Method of Kinetic Spectroscopy," by Professor R. G. W. Norrish. Chemistry Department, The University, Nottingham. Tues., 8 Dec., 8 p.m.

Combustion Engineering Association

LEEDS
"Clean Air Act." Discussion. Northern Region. Great Northern Hotel, Leeds. Wed., 9 Dec., 2.30 p.m.

Illuminating Engineering Society

LONDON
"Lighting of Drawing Offices," by J. B. Collins and F. G. Langdon. Federation of British Industries, 21 Tothill Street, SW1. Tues., 8 Dec., 6 p.m.
LEEDS
"Next Fifty Years of Lighting Development," by R. T. O. Freeth. Leeds Centre. British Lighting Council, 24 Aire Street, Leeds 1. Mon., 7 Dec., 6.15 p.m.
MANCHESTER
"Road Surface Illuminants in the Practice of Public Lighting," by J. B. de Boer. Manchester Centre. Demonstration Theatre, Town Hall Extension, Manchester. Thurs., 10 Dec., 6 p.m.

Institute of Fuel

MANCHESTER
"Clean Air." Open Discussion Meeting. North Western Section. Engineers' Club, Albert Square, Manchester. Wed., 9 Dec., 6.30 p.m.

Institute Marine Engineers

LONDON
"Closed Feed System," by T. O. Leith. Student Lecture. Mon., 7 Dec., 6.30 p.m.*

Institute of Metal Finishing

LONDON
"Air Drying Paint Systems," by F. Dunkley and D. H. Grover. Organic Finishing Group. British Institute of Management, 80 Fetter Lane, EC4. Wed., 9 Dec., 6.30 p.m.

Institute of Physics

LONDON
"Geological Time," by Sir Edward C. Bullard. London and Home Counties Branch. Wed., 9 Dec., 6 p.m.
"The Ultrasonic Camera: An Alternative Approach to Ultrasonic Testing," by J. F. Sayers. Non-Destructive Testing Group. Fri., 11 Dec., 6 p.m.
EDINBURGH
"The New Realism of Physical Theory," by Dr. G. Wyllie. Scottish Branch. The University, Edinburgh. Mon., 7 Dec., 7.15 p.m.
GLASGOW
"The New Realism of Physical Theory," by Dr. G. Wyllie. Scottish Branch. The University, Glasgow. Tues., 8 Dec., 7.15 p.m.

Institute of Road Transport Engineers

BRISTOL
"Turbocharging Diesel-Engined Road Vehicles," by K. B. Hopfinger and R. Tytler. Western Centre. Royal Hotel, Bristol. Thurs., 10 Dec., 6.30 p.m.
CARDIFF
"Glass Fibre Reinforced Plastics," by G. O. Gurney. South Wales Centre. South Wales Institute of Engineers, Park Place, Cardiff. Fri., 11 Dec., 7.15 p.m.
LIVERPOOL
"Use of Plastics in Road Transport," by J. Langford-Allen. West Regional Centre. Liverpool Architectural Society, Bluecoat Chambers, School Lane, Liverpool 1. Mon., 7 Dec., 7.30 p.m.
MANCHESTER
"Taking Stock on Maintenance," by P. H. Wyke Smith. East Regional Centre. Houldsworth Hall, 90 Deansgate, Manchester. Mon., 7 Dec., 7.30 p.m.

Institute of Welding

LONDON
"Plant Characteristics for Welding," by J. C. Needham. South London Branch. Wed., 9 Dec., 7.30 p.m.

Institution of British Agricultural Engineers

LONDON
"Developments in Tractor Transmission Systems and Their Lubrication," by E. S. Bates. Cromwell Hall, Earl's Court, SW5. Wed., 9 Dec., 3 p.m.

Institution of Chemical Engineers

MANCHESTER
"Chemical Engineering Problems in Hydrogen Peroxide Production," by W. R. Holmes. North Western Branch. Manchester College of Science and Technology, Jackson Street, Manchester. Tues., 8 Dec., 6.30 p.m.

Institution of Civil Engineers

LONDON
"Some Post-War Works of the Thames Conservancy," by H. C. Bowen and W. E. Foster. Tues., 8 Dec., 5.30 p.m.*
"Standards of Design of Rural Roads." Discussion introduced by J. T. Duff. Traffic Engineering Study Group. Thurs., 10 Dec., 5.30 p.m.*

Institution of Electrical Engineers

LONDON
"Frequency Patterns for Multiple-Radio-Channel Routes," by B. B. Jacobsen. Electronics and Communications Section. Mon., 7 Dec., 5.30 p.m.*
"Field Suppression of Turbo-Alternators," by J. R. Hill, A. Hunt, W. J. Joyce and D. H. Tompsett. Supply Section. Wed., 9 Dec., 5.30 p.m.*
"Characteristics and Protection of Semiconductor Rectifiers," by D. B. Corbyn and N. L. Potter. Utilization Section. Thurs., 10 Dec., 5.30 p.m.*
"Trends of Electrical Progress and Their Implications," by the President, Sir Willis Jackson. London Graduate and Student Section. Fri., 11 Dec., 6.30 p.m.*
BELFAST
"The Linear Induction Motor," by Dr. E. R. Laithwaite. Northern Ireland Centre. David Keir Building, Queen's University, Stranmillis Road, Belfast. Tues., 8 Dec., 6.30 p.m.
CHESTER
"Generator-Motor Problems in Pumped Storage Installations," by Dr. J. H. Walker. Mersey and North Wales Centre. Town Hall, Chester. Mon., 14 Dec., 6.30 p.m.
EDINBURGH
"Provision of Adequate Electrical Installations in Buildings: Multi-Storey Flats and Maisonettes," by C. A. Belcher; and "Small Industrial Premises," by J. A. Sharpe. South East Scotland Sub-centre. Carlton Hotel, North Bridge, Edinburgh. Tues., 15 Dec., 7 p.m.
GLOUCESTER
"Influence of Consumers' Load-Consumption Characteristics on Metering Practice," by L. B. S. Golds. Western Centre. Gloucester Technical College, Gloucester. Mon., 7 Dec., 6 p.m.*

Institution of Heating and Ventilating Engineers

BIRMINGHAM
"Heat Pump," by J. H. Evans. Birmingham Exchange and Engineering Centre, Stephenson Place, Birmingham. Tues., 8 Dec., 6.30 p.m.

Institution of Highway Engineers

LONDON
Annual General Meeting, at 11.45 a.m. Annual Luncheon, at 12.30 p.m. Park Lane Hotel, Piccadilly, W1. Fri., 11 Dec.

Institution of Mechanical Engineers

LONDON
"Some Investigations into Cold Starting Phenomena in High-Speed Diesel Engines," by Dr. A. E. W. Austen and Dr. W. T. Lyn; and "The Problem of Starting and Operating Diesel Engines at Low Temperatures," by Professor Dr. M. Brunner and Dr. H. Ruf. Automobile Division. Tues., 8 Dec., 6 p.m.*
"Design and Construction of Power Station Feed Heaters," by J. V. Bigg; and "Flash Evaporators for the Distillation of Sea Water," by Dr. Sc. Tech. A. Frankel. Steam Group. Wed., 9 Dec., 6 p.m.*
"Practical Training of Engineers." Discussion. Industrial Administration and Engineering Production Group. Thurs., 10 Dec., 6 p.m.*
DERBY
"Mechanical Design Aspects of the Comet Engine," by F. R. Morley. East Midlands Branch. Rolls-Royce Welfare Hall, Derby. Mon., 7 Dec., 6.15 p.m.
MIDDLESBROUGH
"Effect of Nuclear Radiation on Engineering Materials," by A. H. Cottrell. North Eastern Branch. Cleveland Scientific and Technical Institute, Corporation Road, Middlesbrough. Wed., 9 Dec., 6.15 p.m.
NEWCASTLE UPON TYNE
"Effect of Nuclear Radiation on Engineering Materials," by A. H. Cottrell. North Eastern Branch. Stephenson Building, Claremont Road, Newcastle upon Tyne. Thurs., 10 Dec., 6 p.m.

Institution of Plant Engineers

BRISTOL
"Hydraulics," by E. J. Pegler. Western Branch. Grand Hotel, Broad Street, Bristol. Wed., 9 Dec., 7.15 p.m.
COVENTRY
"Safe Use of Electricity in Factories," by G. L. Leighton. Birmingham Branch. Hotel Leofric, Coventry. Tues., 8 Dec., 7.30 p.m.
GLASGOW
"Automatic Controls for Coal-Fired Shell Type Boilers," by P. J. Turner. Glasgow Branch. 425 Sauchiehall Street, Glasgow. Thurs., 10 Dec., 7.15 p.m.
MANCHESTER
"Generation of Electrical Power from Nuclear Sources," by W. G. Busbridge. Manchester Branch. Engineers' Club, Albert Square, Manchester. Tues., 8 Dec., 7.15 p.m.
NOTTINGHAM
"Education and Technology in Russia," by Dr. I. G. Slater. East Midlands Branch. County Hotel, Theatre Square, Nottingham. Wed., 9 Dec., 7 p.m.

Institution of Production Engineers

LONDON
"Production Engineering Developments in Russia," by Dr. D. F. Galloway. The 1959 Sir Alfred Herbert Paper. Royal Institution, Albemarle Street, W1. Thurs., 10 Dec., 6.30 p.m.*
BELFAST
"Extraction and Fabrication of Aluminium," by D. H. Abel. Northern Ireland Section. Kensington Hotel, Belfast. Thurs., 10 Dec., 7.30 p.m.
HALIFAX
"Epoxy Resin Tooling," by E. M. White. Halifax and Huddersfield Section. Percival Whitley College of Further Education, Francis Street, Halifax. Tues., 8 Dec., 7.30 p.m.

Institution of the Rubber Industry

NEWCASTLE UPON TYNE
"Protection of Chemical Plant," by L. Crompton. North Eastern Section. Eldon Grill, Grey Street, Newcastle upon Tyne. Mon., 7 Dec., 7 p.m.

Institution of Structural Engineers

LONDON
"Multi-Storey Car Parks," by E. N. Underwood. Thurs., 10 Dec., 6 p.m.*
MANCHESTER
"Timber Shell Construction," by H. Tottenham. Lancashire and Cheshire Branch. College of Science and Technology, Manchester. Mon., 7 Dec., 6.30 p.m.

Junior Institution of Engineers

LONDON
"The Engineer's Role in Nuclear Power," by Professor J. M. Kay. Presidential Address. Fri., 11 Dec., 7.30 p.m.*

Manchester Association of Engineers

MANCHESTER
"Recent Developments in Shaft Sinking Techniques," by W. R. Spendlove. Engineers' Club, Albert Square, Manchester. Fri., 11 Dec., 6.45 p.m.

North East Coast Institution of Engineers and Shipbuilders

NEWCASTLE UPON TYNE
"Ship Model Size and Tank Boundary Correction," by A. Emerson. Neville Hall, Westgate Road, Newcastle upon Tyne. Fri., 11 Dec., 6.15 p.m.

Royal Aeronautical Society

LONDON
"Practical Aspects of Compressor Blade Vibration," by Dr. E. K. Armstrong and R. E. Stevenson. Tues., 8 Dec., 7 p.m.
"Flight Safety." All-Day Discussion. Institution of Mechanical Engineers, 1 Birdcage Walk, St. James's Park, SW1. Fri., 11 Dec., 10 a.m.

Royal Institution

LONDON
"Menace of Vibration in Engineering," by Professor R. E. D. Bishop. Fri., 11 Dec., 9 p.m.

Royal Society of Arts

LONDON
"Modern Trends in Industrial Design," by Sir Gordon Russell. Wed., 9 Dec., 2.30 p.m.

Sheffield Metallurgical Association

SHEFFIELD
"Gemstones," by Thorold Jones. BISRA Laboratories, Hoyle Street, Sheffield 3. Tues., 8 Dec., 7.30 p.m.

Society of Instrument Technology

LONDON
"Discontinuous Skill Teaching Machines," by G. Pask. Data Processing Section. Manson House, 26 Portland Place, W1. Mon., 7 Dec., 7 p.m.*
BRISTOL
"New Instruments for Old Processes," by A. E. Hidden. Bristol Section. Department of Physics, University of Bristol, Royal Fort, Bristol 8. Wed., 9 Dec., 7.30 p.m.

Women's Engineering Society

LONDON
"Radar and Telecommunications Research and Development," by Dr. Elizabeth Laverick. 45 Great Peter Street, SW1. Wed., 9 Dec., 7 p.m.*

The address and telephone number of the headquarters of each institution are given below. Meetings in the headquarters town are held there unless otherwise stated. Particulars for this feature should reach the Editor at least three weeks before the date of the meeting.

* An asterisk is placed where it is understood that refreshments are available prior to the time stated.

Association of Supervising Electrical Engineers, 23 Bloomsbury Square, London, WC1. (LANgham 5927)
British Institution of Radio Engineers, 9 Bedford Square, London, WC1. (MUSeum 1901)
Chemical Engineering Group, 14 Belgrave Square, London, SW1. (BELgravia 3647)
Chemical Society, Burlington House, Piccadilly, London, W1. (REGent 0675)
Combustion Engineering Association, 70 Jermyn Street, St. James's, London, SW1. (WHItehall 5536)
Illuminating Engineering Society, 32 Victoria Street, London, SW1. (ABBey 5215)
Institute of Fuel, 18 Devonshire Street, Portland Place, London, W1. (LANgham 7124)
Institute of Marine Engineers, Memorial Building, 76 Mark Lane, London, EC3. (ROYal 8493)
Institute of Metal Finishing. Apply to 11A Gloucester Road, London, SW7. (KNIghtsbridge 9181)
Institute of Physics, 47 Belgrave Square, London, SW1. (BELgravia 6111)
Institute of Road Transport Engineers, 69 Victoria Street, London, SW1. (ABBey 6248)
Institute of Welding, 54 Princes Gate, Exhibition Road, London, SW7. (KNIghtsbridge 8556)
Institution of British Agricultural Engineers, 6 Buckingham Gate, London, SW1. (TATe Galley 8589)
Institution of Chemical Engineers, 16 Belgrave Square, London, SW1. (BELgravia 3647)
Institution of Civil Engineers, Great George Street, London, SW1. (WHItehall 4577)
Institution of Electrical Engineers, Savoy Place, Victoria Embankment, London, WC2. (COVent Garden 1871)
Institution of Heating and Ventilating Engineers, 49 Cadogan Square, London, SW1. (SLOane 3158)
Institution of Highway Engineers, 47 Victoria Street, London, SW1. (ABBey 3891)
Institution of Mechanical Engineers, 1 Birdcage Walk, St. James's Park, London, SW1. (WHItehall 7476)
Institution of Plant Engineers, 2 Grosvenor Gardens, London, SW1. (SLOane 0469)
Institution of Production Engineers, 10 Chesterfield Street, London, W1. (GROsvenor 5254)
Institution of the Rubber Industry, 4 Kensington Palace Gardens, London, W8. (BAYswater 9101)
Institution of Structural Engineers, 11 Upper Belgrave Street, London, SW1. (SLOane 7128)
Junior Institution of Engineers, Pepys House, 14 Rochester Row, London, SW1. (VICtoria 0786)
Manchester Association of Engineers, 18 Booth Street, Manchester 2. (Central 1717)
North East Coast Institution of Engineers and Shipbuilders, Bolbec Hall, Newcastle upon Tyne 1. (Newcastle 20289)
Royal Aeronautical Society, 4 Hamilton Place, London, W1. (GROsvenor 3515)
Royal Institution, 21 Albemarle Street, London, W1. (HYDe Park 0669)
Royal Society of Arts, John Adam Street, Adelphi, London, WC2. (TRAfalgar 2366)
Sheffield Metallurgical Association, 64 Crescent Road, Sheffield 7. (Sheffield 52865)
Society of Instrument Technology, 20 Queen Anne Street, London, W1. (LANgham 4251)
Women's Engineering Society, 25 Foubert's Place, London, W1. (GERrard 5212

"First Class Impudence"

When the Trades Union Congress announced that in the face of continued evasion by the leaders of the Electrical Trades Union it was giving up the attempt to get to the bottom of the most damaging chapter in trade union history since the war, one of the most interested spectators must have been Mr. Edward Heath, the Minister of Labour.

If the climate of opinion is less favourable to the unions than for some years past, and in this we seem to be following in the wake of similar developments in the United States, part of the reason for the change may well lie with the cynicism with which the TUC appears to have been treated. Further back in time lie the untried charges of ballot rigging and influence by external Communist committees, charges that could have led the private citizen in haste to the courts in defence of his good name.

Mr. Heath watches from his headquarters in St. James Square. With a Conservative majority of 100 there is plenty of room for a ginger group to take the floor demanding legislative action to put union ballots under the oversee of the Registrar of Friendly Societies, to introduce to the unions something of the precise legal requirements of such legislation as the Companies Act.

If it gets as far as this it will not impede developments for Mr. Emmanuel Shinwell to describe proposals to legislate for union problems as "first class impudence," as happened once before.

Now Mr. Frank Haxell, the communist general secretary of the ETU, has complicated matters further by his challenge to the TUC to pay the costs of legal action against those who have published accusations of ballot rigging. For the TUC to know what they were defending they would first have to be able to give solicitors exactly those facts which the ETU leaders have failed to bring to the now abandoned enquiry. Without this no brief could be drawn up. And if the ETU leaders were to win their case, or cases, they would presumably be awarded costs.

But the next batch of ETU elections are not far off and the very inability of the TUC to take up the union's challenge may soften any effect of Congress's hint to the members as to their choice.

Listeners and Travellers

Rail passengers and listeners to BBC sound radio have this in common, that both are in the hands of a monopoly. The discontents of travellers, not always with the same amount of reason behind them, have led to the drawing up of a Travellers' Charter by the Federation of South Eastern Railway Travellers' Associations. The aspirations of a group of Yorkshire businessmen has led to the formation of a company, Yorkshire Radio, to provide an alternative sound service in the West Riding. Mr. Geoffrey Hirst, the Conservative member for Shipley, and his supporters believe that BBC regional programmes contain too few genuinely local broadcasts and that an independent sound radio body would play a significant part in local life and affairs.

What wants explaining here is how the company would be run. It might be feared that dependence on advertising revenues could lead to the same standards as those of "independent" television.

With the BBC's charter running out in 1962 and the 10 year statutory period of the ITA ending in 1964, both dates within the lifetime of this parliament, debate on the future form of sound and vision broadcasting is going to be a rising tide.

The Travellers' Charter seeks most of all to end the freedom of British Railways from detailed scrutiny and questioning by the House of Commons. The charter is being studied by a group of Conservative MPs who are to have another meeting with the leaders of the federation. The charter includes the proposals that people travelling to work by rail should receive income tax relief, which seems to be another way of increasing the tax burden of the non-rail traveller, that season ticket holders getting on at stations where there is not much hope of a seat should not pay full fare and that reasonable suggestions from the public for improvements should be more sympathetically considered and actually acted upon.

The charter is in line with generally agreed policy when it urges the Government to take immediate steps to encourage industry and commerce away from the metropolitan areas. It goes on to say that big housing developments which would encourage further daily travel to and from London should be discouraged until the Transport Commission can reliably say that it is able to handle the traffic. This suggests that the short sightedness sometimes felt to have not yet relaxed its grip on the railway chiefs has affected even those who regard themselves as exponents of better railway service.

The Profits of his Company

A sharp spur to success is the direct linking of executives' rewards with the profits of the company. In the United States executive remuneration is commonly known as "compensation"—made up of salary, incentive bonus and "compensation" deferred from the previous year.

The American management consultants, McKinsey and Company, have surveyed 791 stock exchange listed companies in that country and found (*Aviation Week*, October) that in 1957 when the profits over the firms considered fell by 3·2 per cent, the compensation of the chief executives rose by 1 per cent, possibly still reflecting something of the better year, 1956. In the more difficult year, 1958, when the same companies fell by 11·7 per cent, the compensation for the chief executives was reduced by 1·8 per cent.

The wide use of bonus schemes based on the profit figures is the explanation of these cautionary figures. For the firms surveyed in the aircraft industry there was a happier story, at least for the executives. The 1957 aircraft manufacturing increase in profits was 10·7 per cent and the rise in chief executive compensation 3·8 per cent. In 1958 the profit figures had the depressing story of an 18·9 per cent fall to tell. Partly because of the delayed effect of the earlier effect of the previous year chief executives were still 3·6 per cent up in their take-home. Alongside the aircraft manufacturing firms in showing increased reward and diminished profits was the petroleum industry where profits fell 19·8 per cent and chief executive compensation rose by 3·8 per cent.

The McKinsey report also produced some interesting figures on the relationship between the reward of the chief executive and his immediate assistants. Taken over all the firms, with the chief shown as 100, the averages were second executive 73, third 60, fourth 55.

Planning Powers

Local district councils with a population of 60,000 or more may now claim delegation from county councils of important planning functions, according to regulations issued by the Ministry of Housing and Local Government. In special circumstances, to be judged by the Minister, this delegation may be extended to cases of populations below 60,000.

There is a good deal of jealousy between county councils and district councils on this and allied subjects. On the one hand the district councils can claim that they know local conditions best—an argument which probably has most relevance on welfare services. In contrast, the county councils can claim to have an overall view of problems and to be less subject to petty prejudices from local interests. They help to give the lie to the saying that we are a nation of shopkeepers. Within bounds, local patriotism as expressed in local government and decentralisation is desirable in many fields as a principle of administration. The new regulations take it a stage further in practice.

Brighter Factories

Widespread changes in emphasis and in detail are involved in the 1959 Factories Act, about half of whose provisions came into force on 1 December.

The Act places the Minister under statutory obligation to promote health, safety and welfare in workplaces by gathering and distributing information and by conducting or supporting investigation of appropriate problems. A further section of the Act, including precautions against explosive dust, apply from 1 February.

One part of the duties of an engineer under the Act is responsibility, in some cases, for maintaining factory interiors. This falls under the Factories (Cleanliness of Walls and Ceilings) Act, 1937. It is usual for the walls and ceilings of all factories where mechanised power is used and ten or more people employed to come within the cleanliness and painting provisions of the Act. The 1937 Act said that if a whitewash or colour-wash is used it has to be renewed at least once in every fourteen months.

An Order of 1938 allowed approved water paints to be used instead, provided that two coats were given originally and at least one coat applied every three years.

In 1958 an Order admitted approved emulsion paints, two coats to be given initially and at least one coat every five years.

Approved oil paints or varnish are exempt from repainting for seven years provided that two coats were applied originally and at least one coat is applied at intervals of seven years.

All surfaces where paints described in these three paragraphs have been used are required to be washed every fourteen months.

The planned use of colour and the use of modern paint finishes has changed the appearance of many factories and the use of colour has spread to the machines, benches and floors.

Bangkok Appointment

Mr. A. D. Benham, investigating engineer for the New Zealand Ministry of Works, has been appointed a Professor of Engineering at the newly established South-East Asia Treaty Organisation graduate school of engineering, Bangkok.

A holder of the Fulton Medal, the highest award of the New Zealand Institution of Civil Engineering, for his paper on fundamental hydrological research in connection with hydro-electric development, Mr, Benham also holds the MBE for his part in the reconstruction of the Italian and Austrian railways. This part of his career followed war service with the Royal Engineers.

In the ten years Mr. Benham has occupied his post at the New Zealand Ministry of Works, he has directed projects with a collective promise sufficient to meet New Zealand's expected hydro-electric power requirements for the next 40 years. Helicopters, aerial maps and a New Zealand invention, the water jet powered speed boat, have all been brought into use. The shallow-draught water jet boat is now showing signs of being taken up outside New Zealand.

Commercial Processes

PRIVATE industry may soon find itself in a position to participate in the business of processing and reprocessing nuclear fuels. The recent announcement from the UKAEA that in the future private companies will be offered an opportunity to bid for fuel fabrication contracts indicates that the authority does not plan to retain the business indefinitely. Fuel reprocessing will be the logical next step for companies established in fuel fabrication.

Profits to be Earned

Reprocessing costs of the order of 0·35 mill per kWh are required for nuclear power to be competitive in the USA at burnups of 8,000 MW per tonne of fuel. Based on solvent-extraction technology, the cost could be attained by private industry in a plant having a capacity of 6 tons per day. Predictions of nuclear reactor expansion in America put the date for building such a plant somewhere between 1968 and 1973, and it would probably be economical to start stockpiling spent fuel in the near future. Mr. C. E. Guthrie, in his paper "Radiochemical Reprocessing Costs in an Expanding Nuclear Economy," studies the effects of plant size and loading on the cost of radiochemical process in the commercial plants of the future. His assumptions are 300 days per year operation, amortisation in 6⅔ years, and a gross profit before taxes and insurance of 15 per cent. Fig. 1 shows the relationship of cost and capacity, expressed in terms of bulk cost from the point of view of chemical plant operator; and also in terms of refuelling cost from the point of view of the power plant operator. (Nuclear Engineering and Science Conference, paper V-49.)

Fuel Reprocessing Rationalised

Depending on the alloy and the degree of enrichment, fuel from reactors under contract with the USAEC will be processed in four centres: Hanford, Oak Ridge, Savannah River and Idaho. Specialisation will be so rigorous that fuels of different types from the same reactor—blanket and core elements from Shippingport and Enrico Fermi—will be sent to different plants for processing. The need for specialisation arose from the comprehensive nature of the American atomic energy and research programme. All four plants are owned by the AEC and operated under contract by private industry. Low enrichment fuels from Dresden, Yankee, Pathfinder, Piqua, and the natural uranium-oxide blanket of Shippingport will be processed at Hanford, a facility operated by General Electric. Stainless-steel clad oxide fuel and molybdenum and zirconium alloy fuels will be the speciality of Oak Ridge, with Union Carbide in charge. Savannah River, operated by du Pont, has so far been assigned to handle only the core elements of the Enrico Fermi station which uses zirconium clad uranium-molybdenum enriched 27 per cent. All high-enrichment fuel will be sent to the Idaho Plant run by Phillips Petroleum. Fuel of 90 per cent enrichment will come from the core elements of Shippingport, OMRE, Vallecitos boiling water reactor, and the numerous domestic and foreign research and test reactors. In contrast to American specialisation, Britain has only two centres for processing spent fuel. With the exception of Dounreay, all fuel regardless of type and origin will be handled by the Windscale works. Dounreay is to have its own reprocessing plant.

Savannah River Purex Plant

Four years of operating experience with the Savannah River plant were reviewed in the paper "Design Versus Performance of Process Equipment in a Large Scale Radiochemical Separations Plant," by A. W. Joyce, L. C. Peery, and E. B. Sheldon (Nuclear Engineering and Science Conference, paper V-71). Shielding in the plant proved to be heavier than necessary, but building cost would not have been significantly reduced by decreasing shield thickness to the very minimum. Local radiation from unshielded piping (particularly solvent lines) has been a problem and extra local shielding had to be installed. The flow of air through the "hot canyon" is such that upward thermal currents can exceed the normal downward rate. Covers over each module help prevent this, but contamination of the hot canyon crane has reached levels of 50 r per hour in spots. Original design included no pumps or valves in the canyons; the solutions were transferred by steam syphons. For certain applications, for example, where the flow rate must be varied over a range of 3 to 1 or more, pumps are now being developed. In general, seamless stainless steel pipe appears superior to seam welded pipe. None of the canyon vessels is of safe geometry from the point of view of criticality, and it has been found that composition of the cold feed streams must be controlled with great care. Dilution of a nitric acid stream caused significant build-up of plutonium in one vessel, and neutron monitors have now been installed where plutonium can accumulate. Only a few per cent of the solvent inventory is lost per month and plutonium and uranium recovery are excellent.

Changes at the Idaho Processing Plant

The Idaho plant is capable of reprocessing highly enriched aluminium, zirconium, or stainless steel clad fuels. The plant was constructed in 1951-2 and is a direct-maintenance plant, requiring decontamination and entry into cells for repair work. In the original design of the charging cave for the aluminium-uranium continuous dissolvers, individual elements were placed in the dissolvers by manipulators, with visual observation through a lead glass window. Dirt in the cave water often made the slugs invisible and operating the Argonne-type master-slave manipulators in water caused rapid deterioration of some components. The cave was subsequently modified to operate dry. Three perforated plate, pulsed columns are employed in the tributyl phosphate first extraction cycle. Although design decontamination factors have not always been met the activity of the plant product only rarely exceeds specifications. It is expected that if material cooled for a shorter time were processed decontamination factors would be greater. Column upsets occur frequently, sometimes because of malfunctioning of some piece of equipment; often for unknown reasons. Vertical thermosyphon evaporators have replaced the falling film type as intercycle evaporators because the latter required copious amounts of solution for decontamination and it has been impossible to reduce radiation levels for direct maintenance. Concentration of first cycle product from the continuous aluminium-uranium cycle is through a Raschig ring packed steam stripper into a continuous thermosyphon evaporator. This combined unit has been most difficult to control. Under certain conditions excess liquid and product solution is discharged to the cell floor sump. Excess liquid can be recovered by jetting to the waste recovery system but this is not a desirable method of handling high concentration uranium solutions. Investigations are underway to provide a more stable system.

Remote Pulse Generator for Radioactive Pumps

Where radioactive stream flows have to be carefully controlled, Pulsafeeder remote head pumps have been used at Idaho. Fig. 2 illustrates the method of operation. The primary head is of stainless steel in small and oil-resistant rubber in the larger sizes. The smaller size pumps on aqueous streams needed considerable maintenance. Some of the trouble may have been caused by solids or a gummy material in the stream. Performance of the larger pumps was unsatisfactory: eight remote heads have ruptured on certain pumps, admitting radioactive solutions into the transmission line and normally "cold" areas. One primary head has also ruptured. In all cases foreign particulate matter in the pump heads was blamed, metal filings introduced into the system during construction being the chief offenders. Maintenance of proper charge on large pumps has been particularly difficult.

Pyrometallurgy

The growing use of power reactors, and their requirment for a low enrichment fuel, make pyrometallurgical methods economically interesting. A summary of work in this field is given in "Review of Developments in Reprocessing of Irradiated Nuclear Fuels by Pyrometallurgical Methods," by L. F. Coleman, J. H. Schraidt, and G. J. Bernstein. One of the most actively pursued pyrometallurgical programmes is to be incorporated in the fuel cycle of the second experimental breeder reactor (EBR-II). Behaviour of some of the fission product elements not previously investigated has been studied in tracer-scale experiments. As expected, technetium behaved as molybdenum, ruthenium, rhodium and palladium, no selective partitioning between the bulk metal and the oxide slag being found. Removal of the rare earth metals lanthanum, cerium, and neodymium was essentially complete (99 per cent) even in the presence of a large concentration of cerium. Barium and strontium appeared to be removed by preferential oxidation and remained largely in the oxide slag. Cadmium oxide appeared to be unstable under the experimental conditions and cadmium was removed from the system by volatilisation. Iodine, xenon, and krypton when present in greater than trace amounts are removed from the melt at 1,400° C.

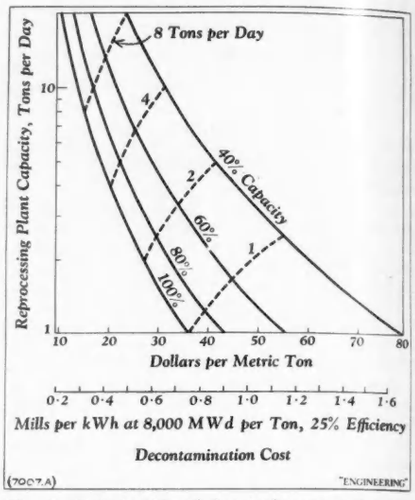


Fig. 1 Relationship of chemical reprocessing cost of nuclear fuel and processing plant capacity.

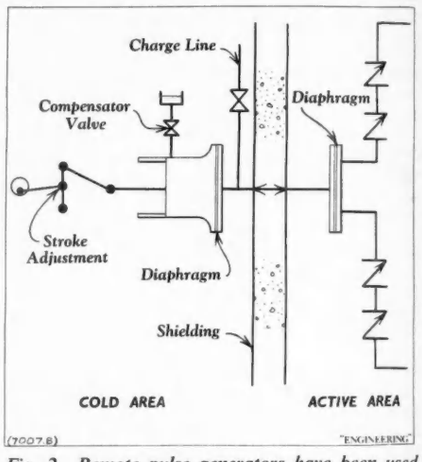


Fig. 2 Remote pulse generators have been used to pump radioactive materials at the Idaho plant.

Although the presence of zirconium as an alloying element aids in the thermal cycling and irradiation stability of ordinary uranium, its presence may be detrimental in reprocessing. It appears to form an intermetallic compound with ruthenium, eliminating the stabilising influence of both elements. Zirconium removal by preferential oxidation is negligible at macroconcentrations. Boride, silicide, nitride, and carbide scavenging of zirconium were tried. Carbide appeared to be the most effective, upwards of 50 per cent removal of zirconium could be achieved with the use of 100-200 per cent of stoichiometric quantities of carbon applied as a crucible coating (5 hours liquation time, 1,400° C).

Plutonium under melt refining conditions behaves like uranium, but addition of carbon to the melt may reduce plutonium recovery. Further comparison of uranium and plutonium systems shows that fission products removed by pyrochemical reactions and volatilisation are much the same for the two systems. Noble metal fission products, however, behave differently, probably because of their lower solubility in plutonium. In addition, drossing times to reach equilibrium appear to be longer in plutonium systems.

Solvent Extraction and Liquid Metal Fuel

Work was done on two basic types: fused salt solvents and molten metal solvents. The first offers the most promise as a means of removing fission products from liquid metal fuels, the second, using molten magnesium or silver as solvents, is being developed to recover plutonium from irradiated uranium. One of the fused salt extraction systems si being studied for the liquid metal fuelled reactor (LMFR). The liquid uranium-bismuth system of LMFR is contacted with a fused salt mixture containing magnesium chloride, sodium chloride, and potassium chloride. Fission product chlorides dissolve in the salt phase. The purified fuel solution is

then separated from the salt phase, reconstituted by the addition of small amounts of uranium, magnesium, and zirconium, and returned to the reactor. Noble fission product elements are not separated and return to the reactor.

Fractional Crystallisation

Fission products may be separted by dissolution of irradiated material in a low melting point metal and subsequent separation through precipitation or crystallisation of intermetallic compounds or metals. The process is known as fractional crystallisation. Three systems recently investigated use bismuth, mercury, or zinc as solvents, and work is under way on a process using mercury as a solvent for purification of uranium alloys containing less than 5 w/o zirconium, molybdenum, or niobium. Preliminary work with zinc as a solvent has given rise to several potential flow sheets. Most fuel alloys can be dissolved, and in addition chemical reactions such as the reduction of uranium oxide by magnesium can be done in a zinc medium. This makes a very attractive procedure for a continuous process as a final step in the conversion of uranium ores to metal, eliminating the hydrogen reduction and fluorination steps used at present. The separation from noble metals and the reduction of oxides are potential advantages of fractional crystallisation not offered by earlier pyrometallurgical techniques. However, the unit operations involved have not yet been tested for remote operation. Filtration and other liquid-solid separations may be complicated. Construction materials are also a serious problem.

Electrorefining

Recent experiments have shown that plutonium can be electrorefined in a similar manner to uranium. An iron cathode is used and the purified plutonium collected as a liquid iron alloy. The molten salt employed was 41 w/o lithium chloride, 50 w/o potassium chloride, and 9 w/o plutonium chloride. Zirconium, molybdenum, ruthenium, lanthanum, and cerium were all removed in this process. The effect of buildup of these elements in the melt has not yet been evaluated, but preliminary results show the method to have excellent potentialities.

Concatenation at the Thorex Pilot Plant

The main object of the Thorex development programme is to demonstrate a solvent extraction process for separation of thorium and uranium from irradiated thorium metal. Pulsed columns are used for all extraction operations and a new form of column, the concatenated pulse column, was adopted for testing. Concatenation is a technique for reducing head room by installing the column in two or more sections. Connections are by organic and aqueous transfer lines containing check valves, the entire assembly being pulsed by a single unit. Eight columns were installed: five standard and three concatenated. The standard vertical columns performed better than the concatenated ones, although not all failures of the latter could be attributed to the columns themselves. Air locking and faults in the check valves were the principal troubles. Hydraulic driven piston pulsers originally installed were found mechanically unsound and impaired the performance of both types of column. All of these units were replaced with diaphragm pumps which have given better, though not entirely satisfactory service. ("An Evaluation of the Design and Performance of the Thorex Pilot Plant," by W. R. Winsbro and G. S. Sadowski, Nuclear Engineering and Science Conference, paper V-73.)

Purex Off-Gas

The Purex ventilation exhaust filter at Hanford was designed for a flow of 126,000 standard cu. ft per min and total initial pressure drop of 4 in water; a collection efficiency of 99·9 per cent for particles in the 0·2 to 0·7 micron range is the aim. Installation of a fibrous glass filter saved $350,000 over a comparable sand filter. It is in two parts: the fore-filter section contains free-packed 115-K fibre 84 in deep (2,700 sq. ft cross-section), and the clean-up filter consists of vertical filter frames containing about 9,000 sq. ft of filter surface. In general the performance has been good. The increase in pressure drop since Purex start-up has averaged about 0·2 in of water per year. To date there has been no evidence of deterioration of the fibrous glass packing from moisture in the gas. Decontamination of the filter has met expectations. ("Design and Operating Considerations for Off-gas Systems in Nuclear Processing Plants," by L. R. Michels (Nuclear Engineering and Science Conference, paper V-72.)

Chemical Explosion Hazard

A standard silver reactor for the extraction of iodine exploded recently at the Hanford separation plant. This was the first incident of its kind in about 8 years operation at Hanford. The exact cause of the explosion is not known, nor can explosive conditions be duplicated in the laboratory. No injuries were sustained and no increase in fission product discharge to atmosphere was detected.

Shearing Fuel Elements

Work at the USAEC Hanford plant with a shear fitted with a straight moving blade and a semicircular stationary blade has shown that 10 per cent more force is required to shear a fuel element can than when both blades are straight. But the straight-semicircular combination causes less fuel element distortion. Life-testing with stainless steel blades has begun. (L. P. Bupp, Hanford Atomic Products Operation, December, 1958. Unpublished.)

Sawing Fuel Elements

With a 10 in abrasive disc and surface speeds of 10,700 ft per min (cutting rate 1 in per minute), about 4,500 cuts through 0·5 in stainless steel rod reduced the diameter of the abrasive disc by a factor of 2. A stainless steel clad porcelain core (simulating a uranium oxide element) could not be cut successfully with a 24 in disc operating at 11,000 surface feet per second. (J. O. Blomeke, H. E. Goeller, and W. H. Lewis, Oak Ridge National Laboratory, March 1959.)

Simultaneous Dissolution

An AEC report states that codissolution of cladding and core material of a fuel element made up of a zircontum clad alloy of 90 per cent by weight uranium and 10 per cent molybdenum is under study at Savannah River. It appears that such fuel elements can be dissolved in boiling mixture of nitric and hydrofluoric acid in a container of wrought 309 Nb stainless steel. At present 11 reactors in the US use zirconium as the primary structural or cladding material.

Recovering Neptunium

Recovery of neptunium from diffusion plant fluorination ash by the Nethix-1 process is described in "Preparation of High Purity Neptunium on Multigram Scale," by P. M. Lanz, W. J. Martin, and G. W. Parker (ORNL-2642, unclassified AEC report). The process yields a neptunium product with less than 1 p.p.m. of thorium or uranium. A series of operations involving solvent extraction, ion exchange, and evaporation are used.

Purifying Plutonium Nitrate

At Hanford studies of the purification of plutonium nitrate solutions by anion exchange are being made. Nitric acid alone as a wash solution produced a zirconium-niobium decontamination factor of slightly more than 10^8 and a ruthenium factor of about 10^4. The addition of 0·1 M phosphoric acid to the wash did not improve the decontamination factor but low concentrations of hydrofluoric acid (0·005 M to 0·05 M) added to the nitric acid wash improved decontamination greatly, giving a zirconium-niobium factor of about 10^6.

Radiolysis of Purex Solvent

Nuclear fuels with high burn-up create problems of radiation damage to solvents used in fuel processing. For example, nitrous acid, produced by radiolysis of nitric acid solutions, must be kept at very low concentrations in Purex systems if neptunium is to be recovered. It has recently been shown (L. P. Bupp, Hanford Atomic Products Operation, December, 1958, Unpublished) that exposure of a Purex scrub solution to a cobalt 60 source (dose rate 0·7 Wh per litre) gave a nitrous acid formation rate leading to an equilibrium concentration of $3{\cdot}8 \times 10^{-3}$ mole per litre after 24 hours at 25° C.

Treating Purex Solvent

Studies have been made of a bauxite slurry treatment for used Purex solvent (AEC report, NCLO-775). Bauxite treatment effectively removed several known uranium complexing agents. It also removed emulsifying agents, as was shown by the more rapid coalescence of the treated solvent. However, the solvent losses in the preliminary tests, 5 to 8·6 per cent, were prohibitively high.

Notes and News

Hawker Siddeley Sell Jason to UKAEA

Excepting certain modifications to permit continuous operation at 10 kW, and differences in experimental facilities, the reactor purchased by the UKAEA from Hawker Siddeley will be identical with Jason, which was started up for the first time only a few weeks ago. Nestor (neutron source thermal reactor) will be installed at the Winfrith Establishment, and will serve as a neutron source for subcritical assemblies of experimental fuel lattices. The flux available for subcritical assemblies will be in the order of 10^8 cm^{-2}, which can be varied by shuttering, changes in reactor power, or by rearranging the fuel load in the core. For liberal and leisured minds: Jason and Nestor were Argonauts who went in search of the golden fleece. Hawker Siddeley's Jason was derived from Argonaut, the water moderated reactor of the Argonne National Laboratories. The rapidly expanding science of reactor etymology has thus reached new depths of subtlety.

Argonaut in Germany

Siemens Schuckertwerke have finished installation of a reactor at Garschig near Munich. It is the first reactor to be fabricated in Germany, although the design is the American Argonaut. Fuel will also be supplied by the Americans. The name of the reactor has not been announced, but judging by Hawker Siddeley's efforts (see above), it might well be Lohengrin.

Test of Detection Methods for Nuclear Explosions

In a few weeks time the UKAEA will start firing conventional explosives in a lead mine in Westmorland in order to perfect detection methods and instruments for the international control of underground nuclear weapon testing. The authority had previously announced its intention to use a disused Cornish mineshaft for similar tests. (Atomic Review, 6 Nov. '59.) The Cornwall tests were to take place in January or February of next year, and were planned on a smaller scale than the Westmorland experiment. Acceleration of the testing programme is caused by disagreement at the Geneva disarmament talks on the detectability of underground explosions. Members of three technical teams from the nuclear powers will be discussing control methods until 11 December. The technical delegations are led by Sir William Penney, Dr. J. Fisk and Dr. Fyedorov for the UK, USA and USSR respectively.

Competitive Fuel Fabrication

Tube Investments, ICI, and several nuclear power consortia are reported to have expressed interest in manufacturing fuel elements under commercial conditions. Capacity of the Springfields plant of the UKAEA, where all the fuel is being produced at present, will be insufficient for the needs of the generating boards' nuclear power programme when fully developed by 1960. The authorities choice is between undertaking a £12 million expansion at Springfield or permitting the participation of private industry.

CERN Proton Synchrotron at Full Power

Meyrin, near Geneva, will have the fleeting distinction of being the home of the "world's most powerful particle accelerator," an honour claimed at regular intervals by both Russia and the United States. The 25 GeV proton synchrotron of CERN, with headquarters at Meyrin, was operated at almost full power (24 GeV) on 25 November, eclipsing the present champion of the proton derby from Dubna, USSR. The Dubna accelerator was designed for a maximum power of 10 GeV, but has been plagued by defects and may never have reached rated performance. J. A. McCone, chairman of the USAEC, had described the Dubna machine as "a white elephant" at a press conference after his return from Russia. The glory of CERN, which is of deep concern to the daily press but immaterial to the scientists who run the machines, will be relatively short lived; a 25 to 30 GeV machine is under construction at Brookhaven, and a 50 GeV synchrotron will follow in Moscow. (Atomic Review, 9 Oct. '59.)

Nimrod Magnets

Magnet sections are now being delivered to Harwell for the proton track of Nimrod at the rate of six a week. Several of the sections are already in position and critical alignment will soon begin. The magnet sections are assembled and machined by J. Sankey of Wolverhampton (ENGNG., vol. 187, 1959, P. 753).

Disagreement on Disposal

An embarrassing disagreement occured at the Monte Carlo conference on waste disposal. The Russian delegation urged that no radioactive wastes should be dumped into the oceans without adequate containment until more is known about ocean currents and biological cycles of marine life. Some high UKAEA officials have expressed the opinion that Russian objections—shared by some Western scientists, oceanographers in particular—are unfounded and impractical. Britain reportedly discharges more radioactive waste to the sea than any other nation.

Air Traffic Control is Ripe for Action

The load on civil air traffic control is growing rapidly. To avoid a crisis in the future, a formidable problem in systems engineering must be solved. A centralised operational research organisation is needed.

There is growing concern for the future of air traffic control. First, several comments on the subject, made to ENGINEERING in recent weeks:

A BEA captain:

Apparently there are only six aircraft on an airway at any one time—it's unbelievable. If an airway cannot accept more than six aircraft it does seem that the present system of air traffic control is sadly lacking.

Although you can take it that the m/f beacon is a primary navigation aid in Britain, it is most inefficient. One of the beacons we frequently use is the one at Dover: very often its range is less than 10 miles. You more or less see Dover before you pick up the beacon. And we are still going along in 1959 with aids like that.

An organisational member of a civil airline:

An early crisis in the ATC organisation can only be averted when operators appreciate fully the impact on their economy . . . there is little doubt that aircraft design advances have now outstripped both development and implementation of the services needed to match striking improvements in aircraft performance.

An RAF officer speaking about the North Atlantic area:

The difficulties result from a system which requires the controller to treat each aircraft as though it had a wing span of more than 100 miles and a fuselage length of the same order.

A spokesman of Decca Radar Limited:

The very large number of aircraft that can be seen on the radar screen at Wisley [the airfield of Vickers-Armstrongs (Aircraft) Limited situated between Farnborough and London] provides food for sober thought. Decca believes that radar surveillance equipment of this quality and discrimination is already long overdue for civil aviation use.

A member of the US Navy speaking about the task of the American air traffic control (ATC) research programme (probably spending more than $10 million annually):

Our aircraft designers have placed a gigantic problem at the doorstep of those of us who are concerned with providing a safe and effective means of ATC. . . . Air traffic is fast reaching a density level that threatens to challenge the capability of the manual system.

An operational research expert who has worked on civil ATC problems:

If the effort had been available earlier and applied more thoroughly to initiate research and develop hardware, we would probably be able to say what equipment we now want for control purposes. But as it is we have got to catch up. Whether we can or not I don't know—it's getting late.

Well, those are some of the remarks that are being made. Some of the more restrained ones.

CIVIL FLYING

Civil ATC is a development of the railway block signalling system. Aircraft travel from point to point along well defined routes between airports. The present system represents a large military and civil capital investment and is likely to be in use for a further decade at least.

Formally, the air traffic control organisation has two objectives: preventing collisions and expediting the orderly flow of aircraft. How well the organisation works is indicated by two quantities: the number of collisions or possible collisions, and the amount of delay suffered by aircraft. Numerical values for these quantities are rarely available. It is likely that Britain is the only country in Europe to have attempted to produce them. The first figure can always be reduced at the expense of the second.

All control is based on the application of two sets of rules—visual flight rules (VFR) and instrument flight rules (IFR). The first only apply when the pilot is at least 1,000 ft from cloud and able to see ahead for 5 miles. Under IFR an ATC centre exercises positive control, advising the aircraft what course and height to fly and so maintaining statutory horizontal and vertical separations between aircraft. The number of aircraft that an ATC centre can control under IFR at any one time is a measure of the control capacity of the centre. This is another number that is not available.

Aircraft flying under IFR may be under procedural control or radar control. In the first case the controller has to rely on reports from the aircraft every 10 minutes or so; consequently, for safety, aircraft must be widely separated, generally at distances of about 50 miles. With radar control the distance can at times be brought down to 5 miles. Another way to reduce the distance would be to fit better navigational aids in aircraft. Procedural control is extremely wasteful of air space.

MILITARY FLYING

Military flying in Britain uses about ten times the number of operational airports that civil airlines do; it is possible to guess that it may make up to 100 times the number of air movements; its aircraft have a wider range of performance than civil aircraft. (Here it might be mentioned that nobody has made a quantitative assessment of air movements over Britain.)

These considerations alone, quite apart from the operational requirements of military aircraft missions, make it impossible to use the type of control system adopted by civil flying. In fact, the only occasion when a continuous military system of control is used is for ground-controlled interception of a target by fighters, and during take-off and landing. Transport and trooping flights use civil airways, conforming to civil regulations.

Needless to say, the aims of civil ATC—avoiding collisions, expediting the movement of aircraft—are to be found in military control philosophy. But the military method is based on the idea that it is only necessary to control aircraft when there is a risk of collision. The pilot can be left to do his own expediting. Thus while a good proportion of military flying is monitored by radar, it is only when a collision situation appears to be developing that control is exercised and the aircraft concerned ordered to change course.

The main difficulty with this system is seeing a collision situation and issuing the avoidance order quickly enough.

INCREASING LOAD

The demands made on the civil ATC organisation are increasing steadily. The increased work load in the cockpit of a civil aircraft—often as a result of reducing crew number—makes the keeping of an adequate lookout from the cockpit difficult and so increases the demand for more flying by IFR. The restricted climbing and descending pattern of jet aircraft make the overall control problem more difficult. In the upper atmosphere the higher speeds and peculiar visual conditions make VFR quite inappropriate. And, of course, the number of aircraft movements is probably increasing.

The increased load on the ATC organisation is directly felt in the ATC centres. Not only that, the increase in load is magnified in the centre. Basically, there are two sorts of information there: that entering it and that circulating round inside it. The latter is essential because it represents the liaison between different controllers who control related air spaces. Any increase in the amount of information entering the centre automatically puts up the amount circulating. It is this magnification process that sets a very definite limit on the amount of traffic that can be handled by the centre.

The two types of air traffic control so far dis-

TABLE I.—HOW TO IMPROVE THE BRITISH SYSTEM OF AIR TRAFFIC CONTROL

Method	Advantage Gained	Stumbling Block
Replanning routes ..	Route could be planned to suit modern air traffic requirements	Large amount of public money would have to be spent. International agreements required. Military-civil agreements would have to be reached
Better navigation aids ..	Aircraft would be able to tell control more accurately where they were, and would be able to follow control's instructions with greater accuracy	International agreement required. Airlines have to spend money on men and equipment
Better communications ..	Controllers would be able to gain a picture of the overall traffic situation more quickly and have a better basis for decision	International agreements required. Civil-military agreements required. Airline expenditure required
Improve data processing ..	By being able to handle data faster, the controller is better able to cope with problems caused by lack of implementation of the above three methods	Negligible compared with top three. The speed of improvement is set by public demand

cussed can be labelled " permissive " (civil) and " safety " (military). The first gives permission to pilots to follow their flight plan along an airway or offers an acceptable alternative; the second only exercises positive control when a collision danger appears, the pilot then having no alternative but to obey the manoeuvre ordered.

There is a possible control system which combines the features of these two and can be called an " indicative " system. This would imply that the pilot was told at all times what manoeuvres he had to carry out. Facilities do not at present exist to analyse quantitatively the respective merits of these three systems when applied to national air traffic.

There are several ways in which the present civil air traffic control system can be improved. The four basic methods for doing this are shown in Table 1. Unfortunately, only at one point in the system can improvement effort be forcibly applied—the air traffic control centre, the point where data processing is concentrated. The first three methods all require international and civil-military agreements before work can be done. The business of securing these agreements goes on steadily, but it takes a long time. To keep up with the rate of development of the ATC problem it is necessary to concentrate effort on areas where work can immediately be carried out. Consequently improvement of ATC becomes a question of improving the capacity of a civil ATC centre to handle traffic. The internal and external limitations on the centre's capacity are set out in Tables 2 and 3.

TABLE 2.—*External Limitations on the Capacity of an ATC Centre*

Capacity of controlled air space
Limitations of aircraft navigation systems
Limitations of centre's radar system
Limitations of centre's external communications
The number of unidentified aircraft in controlled air space

TABLE 3.—*Internal Limitations on the Capacity of an ATC Centre*

Rate at which data can be accepted from outside sources
Rate at which data can be distributed to outside receivers
Rate at which data can be circulated within the centre
Rate at which individual decisions can be reached

WHAT HAS BEEN DONE

Tables 1, 2, 3 give some idea of the scope of the ATC problem. Before and since the Second World War the problem has had the attention of the Air Ministry and the Ministry of Civil Aviation. The only civil ATC Experimental Unit in Europe is to be found at London Airport, and airline pilots recognise the British ATC service as the best in Europe. Other national assets include a few heavily overworked military-civil interdepartmental committee members with a grasp of the overall problem, and a growing realisation in the various Ministries that something expensive might have to be done soon.

Research on certain aspects of civil ATC has shown the need to study the overall problem by operational research methods. The unfortunate feature of operational research is that it can rarely be carried out straight away: there is a delay while research is carried out to find the best way of doing the research.

MILITARY RESEARCH

The Air Ministry have not until recent years been concerned with area air traffic control. Development of techniques of fighter control, airfield control, and radar surveillance are carried out at the Central Fighter Establishment, at the Royal Radar Establishment, Malvern, the Royal Aircraft Establishment, Farnborough, and at Shawbury School of Air Traffic Control.

The problem of area control came to the attention of the Air Ministry when the RAF started to be blamed for a number of alleged near-misses to civil aircraft. To find out what was happening, a joint civil-military committee was set up in 1954 to investigate and analyse reported near-misses. An analysis group, with a chairman from the Air Ministry, carried out the detailed analysis.

The value of this group extended far beyond that contributed by its formal function. Its joint military-civil character meant that the two sides, who had tended to view each other with rivalry, if not hostility, discovered, on sitting round a table and discussing incidents factually, that they had common interests at heart. This led to cooperative action. Analysis of the 1954 and 1955 reports showed, for example, that near-misses were reported on the port side (where the chief pilot sits) twice as frequently as on the starboard side. A campaign to alert civil pilots to the need for a constant all-round lookout resulted in these figures becoming equal by 1957.

Analysis also emphasised the dangers existing in marginal weather conditions, when confusion can arise as to whether VFR or IFR apply. The RAF were the first to take action: more stringent VFR were ordered, the forward distance to be be free from cloud was put up from 1 to 5 miles and lateral and vertical seperation from cloud increased. British airlines quickly followed suit and at a somewhat later date foreign airlines adopted the new rules.

Another outcome of this work was the preparation of an RAF film showing a near-miss incident. Filming was carried out in the Southern Air Traffic Control Centre and in the cockpit of a BEA Viscount. It was then possible to give a realistic presentation of the airline pilot's situation to RAF pilots.

The committee's analyses are said to have shown a steady decrease in near-miss accidents over the past five years. Apparently only in half of the reported cases was there any likelihood of the risk of a collision. The actual magnitude of the collision risk in comparison with other risks of flying is shown by the committee's figures to be very small indeed.

A second impetus to study area control was given by the impending arrival of high-flying civil jet aircraft. The present system of civil airways virtually forms walls 25,000 ft high. Inconvenient as this is from the military point of view, it is recognised as an inevitable part of the present scheme of things. Special procedures are enforced for military aircraft crossing the airways. Such procedures, however, would be intolerable if airways were extended upwards to 60,000 ft, say. The amount of time spent by high flying civil aircraft in the airways would be out of all proportion to the difficulties caused to military flying.

Three years before the present generation of civil jets were in service a limited investigation into the theoretical aspects of controlling traffic in the upper air space was started. An example of recent work is provided by an experiment, lasting two months, carried out with a military radar unit in Ireland. Ministry of Transport and Civil Aviation staff were invited to take part. As a result a military controller and a civil controller operated side by side at two radar consoles. Airlines—BOAC and Pan American, for example —were offered a safety service over the north-western edge of the north Atlantic. Military aircraft were offered the same service. The system was based on the military philosophy of controlling aircraft only when a collision risk appears. During the two months only one civil aircraft had to be deviated. Although the number of aircraft was comparatively light, the experiment was sufficiently successful to justify its continuation in other areas—probably next with a military radar in the south of England. The chief difficulty with the system has been to find a quantitative measure of safety for it.

Out of studies and cooperative experiments such as these, a gradual awareness of the problem of area control is appearing in the Air Ministry. A study of area control is to be carried out in East Anglia—the RAF and USAF rank this among the most congested air spaces in the world. A Military Air Traffic Services Headquarters has been set up at Stanmore, Middlesex.

The unit is at present fairly small, with no research facilities of its own; it is under the control of an Air Commodore.

CIVIL RESEARCH

Experimental research into aspects of civil ATC is carried out by the ATC Experimental Unit of the Ministry of Aviation. The unit does not decide policy but provides information on which policy is based. Civil experimental ATC research is directed largely from the headquarters of the Ministry of Aviation, where theoretical studies are carried out. A joint military-civil steering committee for the experimental unit exists.

The Experimental Unit was set up in 1947 to determine the likely value of radar to air traffic control. By 1950 the value of radar was established. By this time also, the experience of the unit had shown the value of research on equipment and procedures used in air traffic control. Some of the studies that have since been carried out include an examination of the possible use of automatic data processing, study of jet aircraft let-down patterns, photographic studies of aircraft landing behaviour, and radar data processing.

A very flexible type of radar simulator was developed at the Experimental Unit for training purposes. At present a simulator capable of representing 20 aircraft as seen by three radar stations is in the final stages of completion, being used during the past fortnight to simulate 15 aircraft in an investigation of the air traffic control problems posed by a proposed new airway in the Manchester region. Fifteen " drivers " sit at input panels where they " fly " the blips which represent their aircraft on the radar screens in a simulated ATC centre. Controllers in the centre are equipped with R/T links to the drivers and telephone links to other simulated centres. In this way it is possible to make quantitative measurements in a system that comes very close to the real thing. In an experiment like this some 40 people are involved.

Another valuable function of the unit is that it provides a permanent centre that people interested in air traffic control can come to. It is visited by military personnel, foreign ATC bodies, equipment manufacturers, and others. It provided much of the background information for this report.

OPERATIONAL RESEARCH

The Experimental Unit is an experimental centre unique in Europe. There are signs, however, that in spite of its energy and growth, it needs to expand still more. Originally set up to investigate equipment, it is now examining more and more the functioning of the larger aspects of ATC systems. From equipment evaluation it is entering into operational research. For this work a bigger research staff and more equipment of its own are called for. ATC research has been preoccupied in recent years with ideas on ATC systems; now it needs hardware to test the ideas in action, and research effort is needed to analyse the overall system performance.

With the recent setting up of the Air Traffic Control Board and reorganisation of Ministerial departments, the opportunity is, no doubt, being taken to re-examine the research needs of ATC. There is every indication that considerable power is to be given to the Board. It is charged with formulating air traffic control policy for the United Kingdom, and has as its chairman Sir Frederick Brundrett.

Administration and funding of an operational research centre is going to present special problems. A reasonable degree of autonomy is required. The essence of such a reorganization would seem to ensure the minimum of delay between the initiation of research in a particular field and its satisfactory completion This requires not only research staff but a back-up organization geared to the requirements of research work and able to keep pace with it.

The organisation would not only be of value to aviation. Both military and civil research groups admit a desperate shortage of operational research men. A centre of sufficient size to show that serious interest is taken in the subject would attract suitable staff. It would also accumulate experience which industry would find extremely valuable. For the ATC operational research problems of today are likely to be industry's problems in the future.

Sea Pipeline Weighing a Ton a Yard

A 6,000 ft long pipeline, heavily proofed against corrosion in tropical seas, has been laid in Ga Lagoon, Gulf of Guinea, by Taylor Woodrow (Ghana) Limited, working in association with Collins Submarine Pipelines Overseas Limited. The pipe forms a sewer outfall from Tema and it is one of the few such pipes so far to be laid on the sea bed at a point sufficiently far from shore to avert all danger of contamination.

Basically the pipeline consists of 210 Stewart and Lloyds' steel pipes of 27 in internal diameter welded together to make the full length. Externally it is covered with layers of enamel, glass fibre and bitumen which are surmounted by 6 in of reinforced concrete. The inside of the pipe is lined with a bitumen-sealed layer of cement mortar that was applied by a machine travelling along the pipe interior (this work was carried out by Mowlem Centrilene Limited as sub-contractors). As finished, the pipeline has an outside diameter of 42 in and weighs more than 1 ton per yard. The work, which began in April of this year and has taken six months to complete, was carried out by 150 Ghanian, British and American workers, including a team of welders from the United Kingdom.

The pipeline was constructed on shore on launching trolleys and then hauled into the sea by a winch stationed on a barge anchored outside the Lagoon. To ease launching, the leading end of the pipeline was encased in a 40 ton concrete pulling sledge which has also helped to anchor the pipe in its final position where it lies in 35 ft of water. As the photograph shows, the pontoons were used to keep the pipeline light as it was drawn across the sea-bed. The pontoons were later freed by a patented release opened by skin divers.

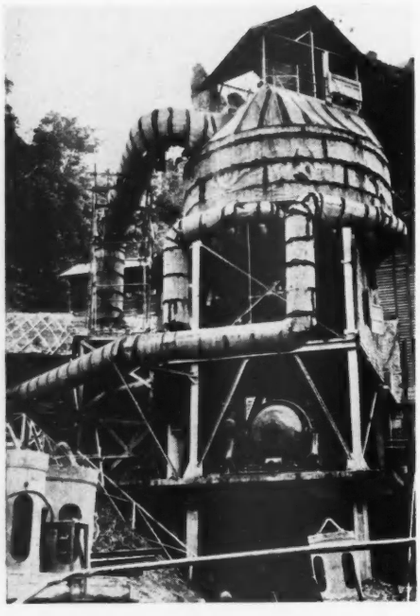
To ensure that the barge was correctly positioned, large targets were erected inland, on which the tug could align. Control of the whole operation was from a tower communicating with the barge by radio-telephone.

Launching the pipeline into an artificial cut leading to the lagoon. Note the bouyancy chambers and the launching trolleys.

The contract, placed by Ghana Government Tema Development Corporation, was worth about £500,000. The consulting engineers for the project were D. Balfour and Sons, of London.

Concrete Cooling in Dam Construction

For the construction of the recently completed Klang Gates dam at Kuala Lumpur, Malaya, extensive plant was installed to lower the temperature of the concrete as it was placed. Under tropical conditions, large concrete masses are prone to excessive shrinkage (and consequent cracking) that follows from the rapid hydration of the cement, increased evaporation of the water, reduced strength and large volume changes.



Cork covered concrete plant at Klang Gates dam, Malaya with the refrigeration plant behind.

The plant installed at Klang Gates was designed to pre-cool the concrete by circulating refrigerated air through the aggregates, chilling the water, and by providing flake ice for addition during mixing. The necessary refrigeration plant was supplied by York Shipley Limited, of London, to Blaw Knox Limited, the main contractors responsible for the concrete mixing plant.

A placing temperature for the concrete of 48° F was specified in a location where the air temperature averaged 85° F, which was also the mean temperature of the aggregates. The water had a natural temperature of 80° F. The concrete output was 22 cu. yd per hour over a 12 hour working day. Four separate refrigeration plants were selected: (*a*) air cooling for the aggregate; (*b*) water cooling; (*c*) ice manufacture and (*d*) ice storage.

The method adopted to cool the aggregate was to supply cold air at 35° F to the four compartments of the batching tower which held the graded gravel, centrifugal fans driving the air through cooling coils in the delivery ducts. More ducting from the top of the tower returned the air to the fan suction chamber. Cork insulation was provided for all the ducting. Working in conjunction with the air cooling coils were four York single acting ammonia compressors, each belt driven by 110 h.p. motors; shell and tube refrigerant condensers; a high pressure receiver; and two centrifugal condenser-water circulating pumps.

The aggregate storage bin, designed and built by Blaw Knox, was divided into six compartments: two of 50 cu. yd capacity each for sand and $\frac{3}{4}$ in aggregate, three of 33 cu. yd for $1\frac{1}{2}$ in, 3 in and 6 in stone, and one silo for storing up to 50 tons of cement. This storage capacity was chosen to ensure that the coarse aggregates had a minimum of 90 minutes exposure to refrigerated air. Slab cork, 3 in thick, was used to insulate the bins.

To cool the mixing water a Baudelot chilling system was provided. This comprised a steel tank in which there was a galvanised steel cooling coil. Water was pumped from the source to the storage tank and circulated by a small pump over the cooling coil. A transfer pump of 40 gallons per minute was used to pump the chilled water to the batching plant. The refrigeration plant included a 5 in compressor.

Additional cooling requirements were met by the addition of ice in ribbon particle form made in four York flake ice machines; an ice storage was built below the plant. To transfer the flake ice to the batching tower a screw conveyor was fitted under the ice store and feeding into a bucket elevator. This discharged over a balanced hopper which, in turn, charged a weigh hopper below it. The ice finally joined the aggregate and cement in a common collecting hopper for all weighed materials. At all stages of ice handling cork insulation was provided.

The concrete was mixed in a large capacity tilting drum mixer built below the operator's platform from where all the weighing, mixing and discharging was controlled. For conveying to the point of placing, the concrete was put into bottom-discharge crane skips moving on rail mounted trolleys. It was finally placed in position along the dam well by derrick crane.

The dam was designed by the United States Bureau of Reclamation and built by the Public Works Department of Malaya at a cost of £1,600,000. The wall is 100 ft high and has a crest length of 450 ft; it will impound 4,000 million gallons of water in a lake of 750 acres. During dry spells the towns of Kuala Lumpur and Petaling Jaya will together take about 32 million gallons of water a day. Construction of the project took three years, of which concrete placing occupied 17 months.

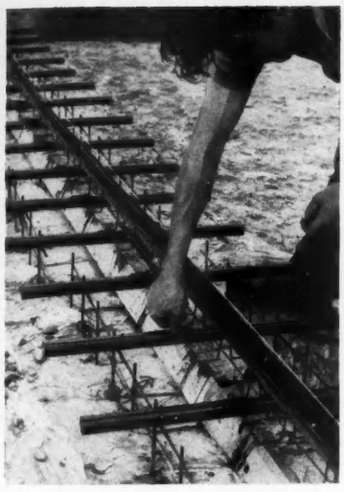
Mortars for Brickwork

The ideal jointing mortar combines good working properties with the early development of strength, while its mature strength will be no greater than is sufficient to meet the purpose for which the masonry is designed.

Recommended mixes for different classes of work and for varying conditions are given in a Building Research Station digest No. 126 *Mortars for Jointing*, published by HM Stationary Office (price 4*d*). Three particular classes of work are considered: external walls, internal walls, and tall chimneys. Brief comments are made on the choice of materials.

Watertight Joint for Concrete Roads

A complete absence of above the surface protrusions is claimed for the Fisher joint for concrete



Wiring the Fisher joint.

roads. The joint is made of a flexible extrusion of a resilient synthetic rubber which is built into the concrete at the time of construction. The illustration shows the joint assembly being wired to the dowel bars.

About 6,000 ft of the jointing has been used along the new St. Albans bypass. It is marketed by Stuart B. Dickens Limited, Victoria Street, London, SW1, and was developed in the research and development department of John Laing and Son Limited at Boreham Wood, Hertfordshire.

Hydraulic Investigation in North America

A comprehensive catalogue of hydraulic research being undertaken in North America is contained in *Hydraulic Research in the United States*, published by the US Department of Commerce as the National Bureau of Standards' miscellaneous publication 227 (price $1·25). Contributions from Canadian laboratories are also included.

The range of work reported embraces both mechanical and civil in the broadest sense. Thus the US Department of Agriculture has in hand a study of methods of preventing watershed deterioration on " operated " forest and related regions in Idaho. Elsewhere investigations are being undertaken on ship movements through canals; characteristics of water intakes; snow course measurements; and surge tank behaviour. On the mechanical side work is reported on flow through turbines and fluid flow in pipe networks.

Each project is listed under the name of the laboratory where the work is being undertaken, and the following information is given: the sponsor of the work and the name of the man in charge; the nature of the investigation; the present state of the work and results obtained to date; and publications.

Electronic Computer for Road Research

The Road Research Laboratory, of the Department of Industrial and Scientific Research, at Harmondsworth, are to instal a general-purpose Pegasus computer to examine all aspects of road research, in particular road traffic and safety problems. Another Pegasus has been ordered by the Steel Company of Wales. Intended primarily for research studies, it will be installed in the operational research department at the Abbey Works, Port Talbot.

Ferranti Limited, the makers of the machines, have now sold 30 of them—valued at more than £150,000 each.

Standardising Contractors' Plant

At a meeting in London of the Council of the CECE (European Committee for Construction Equipment) it has been agreed to form further sections as follows:—

Section VI.—Excavators, single-purpose and multi-bucket; and Trenchers.
Section VII.—Dumpers.
Section VIII.—Tractors, crawler and wheel mounted and ancillary equipment; loading shovels, graders and snow ploughs.

The equipment covered by these three sections was formerly a matter for the Fédération Européenne de la Manutention, but it was agreed with that federation that the equipment should be transferred to the CECE, which now covers the whole range of construction equipment.

The annual congress of the CECE is to be held in London on the 9, 10 and 11 May, 1960. Member countries of the CECE are Belgium, France, Germany, Italy, Switzerland and the United Kingdom.

Sixteen Paraboloids in One roof

What is the largest shell roof in the country has been built in timber at Haughley Park, near Stowmarket, Suffolk, for an egg packing station.

The roof comprises 16 hyperbolic paraboloid panels, each 45 ft square, to give a total covered area of 32,400 sq. ft. The shell consists of three layers of $\frac{5}{8}$ in tongued and grooved boarding laid down on a jig. All the boards were pressure treated with a fire retardent and were glued together at the edge of each panel with Aerolite 300 over a strip 3 ft wide. Over the remaining area the boards were stapled and nailed. The edge beam consists of ten layers of $\frac{7}{8}$ in boards laminated with Aerodux 185 resorcinol resin adhesive. At the low corners of each panel there are ties of Macalloy rods. Every shell has a cover of $\frac{3}{4}$ in insulating board and Evode roofing material for waterproofing.

Ballast Cleaning on Midland Region

The London Midland Region of British Railways is retrieving about 60,000 tons of ballast for re-use by washing old stone withdrawn from the track.

After ballast has been in the track for a number of years it becomes clogged with ash from locomotives and wagon spillage. It is also not uncommon to find that clay or other substances from the formation has worked up into the stone. These inclusions prevent the ballast from fulfilling its function as a drainage medium so that track stability is lowered, sleeper decay accelerated and weed growth encouraged.

The region has established a washing plant at Sandiacre able to handle 80,000 tons of dirty ballast a year. The plant consists of two Contraflow washing machines, with hoppers, rotating screens fitted with baffle plates to agitate the ballast, and conveyors to load the washed material into wagons. At the discharge end of the washer the ballast is graded by screens into four sizes as follows:—

1. Oversize material, for back-filling drains.
2. Standard size ballast for re-use in the track.
3. Small size ballast which is re-used in tunnels.
4. Chippings, used for measured shovel packing under sleepers.

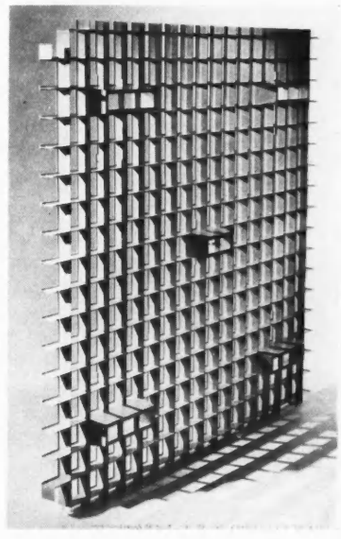
Civil Engineering Scholarships

It is hoped that the number of scholarships awarded by the Civil Engineering Scholarship Trust will be increased to 20 next year. This has been made possible by a donation made to the Trust by the Godfrey Mitchell Charitable Trust.

In 1958, when it was founded, the Civil Engineering Scholarship Trust (which is sponsored jointly by the Institution of Civil Engineers, the Federation of Civil Engineering Contractors and the Association of Consulting Engineers) was able to make 10 awards. Last year the number was increased to 17. The scholarships, which average around £350 a year for three years, are intended to assist the sons of parents who, because of a means disqualification, are unable to benefit from State and local government awards.

Moulded Packings for Cooling Towers

Moulded high-density polyethylene is being used for the packing in water cooling towers. Known as the Polygrid Plastic Packing, the assemblies are offered as substitutes for the wooden slats that have been used in conventional systems to break up the falling water. The new plastic grid, as illustrated below, is a result of joint work by Head Wrightson Processes in this



Cooling tower packing of moulded plastics.

country and Fluor Products Company in the United States. Ekco Plastics of Southend are doing the moulding of the grids in the United Kingdom.

The grids can be either interlocked when assembled or spaced at intervals depending on the duty they have to perform. Each grid measures about 3 ft square but weighs only 4 lb. For uses in which the water contains no hydrocarbons, high impact polystyrene is recommended in place of polyethylene. Claims for the grids include an expected longer life than for the wooden slats and easy assembly in the tower.

Rotary Piston for Internal Combustion

A lightweight internal combustion engine has been developed on the rotating piston principle. The engine has only three rotating parts.

Since the introduction of the Otto cycle, internal combustion engines have been steadily refined but the original layout of crank, connecting rod, piston and cylinder has not changed. There were many departures, and some—like the Gnome engine of First World War fame—enjoyed temporary success, but in each case the industry soon reverted to a more or less conventional layout. Other proposals like the Omega engine, which caused a flutter of excitement a little while ago, were technically interesting but posed machining and assembly problems which made their production impracticable. Patent Offices around the world are now cluttered with dusty inventions of diabolic ingenuity and almost equal impracticability.

NSU, the German motorcycle and moped makers who have recently branched out into automobile production (the NSU Prinz) have developed a radical new engine which also appears to be practical. Development started six years ago and culminated in the demonstration of a prototype in New York last week. Production models are expected to appear early next year. The invention belongs to the "rotary piston engine" class, of which pneumatically operated motors have been built before. The principle involved is the construction of a chamber of variable volume, which is defined by members rotating inside one another. The emphasis is placed on rotation: reciprocating parts are eliminated in order to avoid the inertia forces exerted on the components. The arrangement permits higher rotative speeds and lighter components, and opens up possibilities of weight reduction.

Engines of the type will be built by NSU in sizes from fractional horsepower for mopeds, through motorcycles, and up to 100 h.p. for automobiles. The American Curtiss Wright Corporation will concentrate on larger sizes, presumably for aircraft propulsion. Apart from aircraft engines, Curtiss Wright have also developed an air-cushion supported vehicle.

The first prototype of the rotary piston engine was unveiled in New York last week. From 125 c.c. displacement the 20 lb engine develops 29 b.h.p., it is claimed. Assuming for the sake of argument that the quoted performance is for continuous operation, the specific weight of the engine is 0·7 lb per b.h.p., and this may be further reduced by the use of light alloy instead of steel. This compares with 2·70 lb per b.h.p. for the popular four-cylinder 65 horsepower Continental aircraft engine, and 1·31 for the 3,400 h.p. 18 cylinder supercharged turbo-compound twin-row Curtiss Wright engine. Even if the weight of the requisite pinch of salt is added, the reduction remains impressive.

The illustrations below show a two-cylinder (two combustion chamber) arrangement of the NSU design. Several other variants have been patented and the model shown in New York had three combustion chambers. The principle of operation, however, is the same. The engine consists of three rotating members: the outer race (1), the inner race (3), and the cam (6), which takes the place of the valves. All three components rotate clockwise, with speed ratios of 4 to 2 to 1, in the order listed. A complete cycle of events takes place in one revolution of the cam, but four revolutions of the outer race. Operation is pure "four-stroke," requiring neither assisted aspiration nor scavenging. The combustion chambers (2) have a phase difference of 90° expressed in terms of cam-angles. As the assembly rotates, the volume of the top combustion chamber increases owing to the eccentricity of the outer race and the geometry of the inner race. The inlet port is open and fuel mixture is drawn from a carburettor of conventional design. In stage (*c*) the two combustion chambers have equal volume, and in stage (*e*) intake is completed. The intake port is closed by the cam and compression begins. Ignition occurs at stage (*j*) from a single spark plug located at the back of the engine. Expansion follows until the exhaust port begins to open in stage (*n*), after which the combustion gases are expelled. The opposite combustion chamber goes through a similar cycle. The pressure-volume diagram of Fig. 2 illustrates the sequence of events in both chambers.

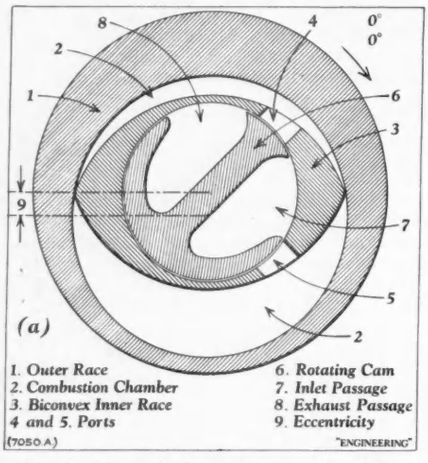


Fig. 1 Two-cylinder rotating piston engine.

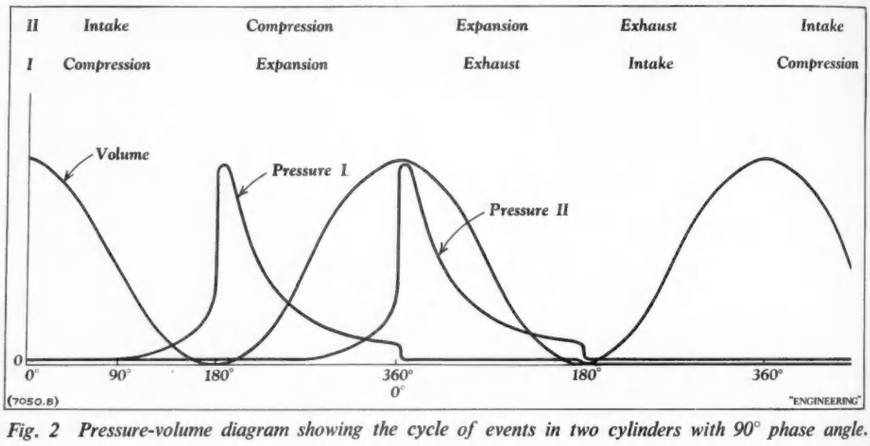


Fig. 2 Pressure-volume diagram showing the cycle of events in two cylinders with 90° phase angle.

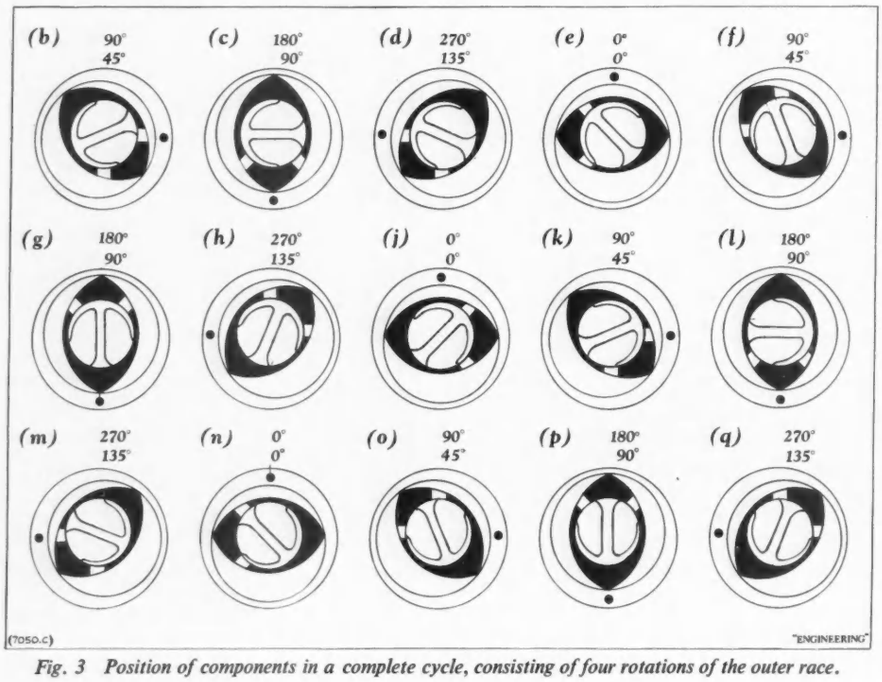


Fig. 3 Position of components in a complete cycle, consisting of four rotations of the outer race.

Packing of the sliding members at the back and front of the engine is likely to be troublesome, but Felix Wankel, the inventor, claims that steam engine practice has produced a satisfactory solution. From the point of view of fuel economy, the engine's performance is not likely to be spectacular. At least two of the principles laid down by Otto for the ideal IC engine are violated: the combustion chamber shape is far from spherical, and expansion is not as rapid as in a conventional crank and piston engine. But the simplicity of the layout and the high rotating speed attainable may compensate for any deviations from the ideal engine.

Felix Wankel is an inventor of a type not often found today. He has been patenting on the average some ten inventions every year, including all the production methods and tools necessary to make his engine. R. T. Hurley, president of Curtiss Wright, said that he believed Wankel's engine would revolutionise the entire field of internal combustion.

Ring Out the Old

Siemens Edison Swan, British Thomson-Houston, Metropolitan-Vickers Electrical — these are famous names in British industry. From January, 1960, BT-H becomes Associated Electrical Industries (Rugby) Limited; the Siemens company becomes Associated Electrical Industries (Woolwich) Limited, and Metropolitan-Vickers becomes Associated Electrical Industries (Manchester) Limited.

The divisionalisation of AEI will be complete. Twelve product divisions will then be operating, five of them new sections of the AEI concern all newly announced by the chairman, Lord Chandos. The five new product divisions are: cables, construction, telecommunications, radio and electronic components, and instrumentation. The instrumentation division combines the interests of Sunvic Controls with the instrument and meter, X-ray and scientific apparatus departments of Metropolitan-Vickers and is to be managed by AEI (Manchester). Lord Chandos, announcing the completion of AEI's divisionalisation programme, made it plain that the 103,000 AEI employees will all find their conditions of service, length of service, and benefits unchanged. He explained to ENGINEERING, at his London headquarters, that the new form of organisation would give some advantages over the old " unitised " system in competition with other companies.

" This is the end of an important phase in the history of the development of AEI," said Lord Chandos. " Of course the internal organisation of AEI is not fossilised but the process of divisionalisation with special concentration on groups is now complete."

The form of organisation of Associated Electrical Industries will be three group companies, controlling product divisions, under the overall AEI board. They will be:

AEI (Manchester), formerly Metropolitan-Vickers Electrical, controlling the AEI turbine-generator division, AEI switchgear, AEI transformer, AEI traction, and AEI instrumentation.

AEI (Rugby), formerly British Thomson-Houston, controlling AEI heavy plant, AEI motor and control gear, AEI electronic apparatus, AEI-Birlec, and AEI lamp and lighting.

AEI (Woolwich), formerly Siemens Edison Swan, controlling AEI cable division, AEI construction, AEI telecommunications, and AEI radio and electronics components.

With the struggle at present being fought out in the cables industry interest centres on AEI intentions for the cable division. The division combines the former SES cables division, W. T. Henley's Telegraph Works, and Liverpool Electric Cables. Lord Chandos stated that rationalisation in the cables division would be complete some time in 1960. " A new organisation to meet a new world," was the chairmans last word.

150 Years On

Is it possible to get a scientific, or any other education, without coming to know the name Blackie? Even further back than one's childhood recollection of the first reader with that evocative name down the spine goes the history of the great firm itself. Back 150 years to 20 November, 1809.

In their modern dress, Blackie and Son, known all over the world for their scientific and technical books, are widening their attentions from the bias towards physical science and mathematics to include the engineering works in which American publishers have established such a name, at least in the West. The youth and drive of the 150 year-old Blackie company is best seen in their invitation to any physical scientist or engineer who reads about their anniversary. If he has any suggestions or proposals for new textbooks or reference books he should get in touch with a Mr. T. Rivington at Blackie's and put them forward.

A comparative stripling beside Blackie's, Continental Publishers and Distributors Limited, are celebrating their centenary this year. On 6 May, 1859, the Librairie Hachette was opened in a turning off the Strand no great distance from the offices of this journal. A natural meeting place for the French community in London, the Librairie expanded to earn a reputation as " the place " for foreign books at a time when travel on the continent, for those with the money, was less form-ridden than today. Given a crisis, the Franco-Prussian war, the firm began publishing books for modern languages in schools and still serves schools today. The firm Messageries Hachette, formed in Paris in 1898, became a unique world-famed institution for the distribution of text books, literature and foreign language periodicals. Acquiring its present name Continental Publishers and Distributors Limited in 1937, the company lost its headquarters at La Belle Sauvage by bombing in 1941.

Now in mid-century, when the free and rapid exchange of news, information and opinion is essential in the struggle of ideologies no less than in the maintenance of industry and commerce, CPD are there, a key link in international communication.

Revolutions and the BMC

Of much wider significance than for motor manufacturers only were Sir Leonard Lord's words on change and development in his annual statement, on the British Motor Corporation's year up to 31 July.

" The motor industry is one in which the manufacturer has from time to time to face a period of fundamental change. To assure the future, existing and successful products must give place to new. Only in this way can the major producer maintain his position in the forefront of competition. This transition must be smooth and efficient, and to avoid dispersal of skilled labour and minimise fall of output and revenue, makes heavy demands on management," said Sir Leonard.

The big changeover for the BMC began in September, 1958, with the first public announcement of the new A 40 and went right on up to the last introduction of the financial year, the A 99 in July. Six other models also appeared between those two dates.

Had it not been for the series of strikes that disrupted schedules, BMC would have achieved this change-over and a record output for the year. As it was the drop from the previous year, 504,712, was one of only 4 per cent, to 486,048 vehicles, including 92,854 new models. The importance of technical innovation and keeping the BMC's sports cars in the front of world development is best shown in the sports car figures—of 44,889 such cars made in the year, 40,115 were exported.

For the future Sir Leonard looked forward from the present production rate (including the new mini-cars from their special £10 million plant) of 750,000 vehicles a year to " the magical figure of 1,000,000 units a year." This will need new sites, new factories, and £49 million of capital expenditure between now and 1962.

BMC do not expect to have to raise fresh capital to do all this. With an order book three times that of the same period in 1958, Sir Leonard looks to getting his money from rising profits and the corporation's own resources. The success of British cars in the United States is one of the most vigorous notes in the booming car industry. BMC's share is 69,060 cars sold in the States and an expectation of selling more than 100,000 there in the current year. BMC dollar earnings are now at $110,000,000 a year.

While the Australian company is now " turning the corner," the South African plant's earnings dropped by 5 per cent from the year before and the Canadian subsidiary increased its earnings by 18 per cent. Before July, 1960, it is hoped to have a new subsidiary ready to operate at Umtali, Southern Rhodesia. £1 million have been set aside for this and the first contracts placed. Although BMC have an Italian agreement which gives them a door into the European Common Market, Sir Leonard, like so many others, foresees increasing discrimination as we trade in Europe and for this reason the corporation supports the British plan for European Free Trade.

Standard-Triumph International

With the introduction of the Triumph Herald car, the selling of the tractor assets to Massey-Ferguson, the start of a £6 million expansion scheme and a record profit, Lord Tedder could well tell shareholders of Standard-Triumph that the year had been most eventful.

Part of the conditions of the sale to Massey-Ferguson was that Standard-Triumph would not make tractors until 1 May, 1961, the date on which the agreement would otherwise have run out. This has left surplus capacity, some of which has been taken up with new contracts and other work is being sought. The rise in the production of cars and tractors from 147,616 in the previous year to 158,856 this year is accounted for by increases in cars alone. The daily output of cars is now running at 600 and from the spring of 1960 this should increase progressively to 735 a day (180,000 a year).

The lack of painted and trimmed car bodies which has held back the expansion of Standard car sales for the last three years is being rectified by the installation of a new plant at Canley, by buying the Coventry works of Fisher and Ludlow and also that of Mulliners. This of course brings forward the day when Standard-Triumph will reach the limit of their assembly facilities. The £6 million expansion scheme includes new plant to meet this need, and new offices following the move from Banner Lane. The engine, gearbox and axle plant are also to be modernised.

Lord Tedder denied what he described as the growing impression that the company was relying solely on the Triumph Herald. The Vanguard saloon and estate cars, the Triumph T R 3 and the Atlas van were all in greater demand than the production capacity could meet. These models accounted for more than half the company's current output.

Overseas development is also going ahead. Permission has been given for the building of a new assembly factory in Belgium to supply the European Common Market. The Triumph Italia, well received in Italy, is having 50 per cent of its numbers produced locally. The subsidiary in Australia has been reorganised and, said Lord Tedder, its recovery has been " remarkable."

Richardsons Westgarth

Extensive changes in the organisation of the Richardsons Westgarth group of companies, which involve the coordination of their marine engineering subsidiaries, were announced recently. The production and technical activities of the three companies concerned—North Eastern Marine Engineering, Parsons Marine Turbine and George Clark and North Eastern Marine (Sunderland)—will come under unified direction as the Marine Division of the group, although each will continue to operate under their own name " by reasons of established connections and good will."

The overall responsibility for the coordination of these activities will be undertaken by Rear-Admiral J. G. C. Given, at present managing director of the Parsons Marine Turbine company, as managing director of the marine division. Mr. H. Kay, at present a director of George Clark and North Eastern Marine (Sunderland), will be assistant managing director.

Ice Protection on the Lockheed Electra

Hot engine-air is used for de-icing the Lockheed Electra. Numerical and analogue computer methods were used in the design; and to reduce flight testing time icing wind tunnels, flying test beds and artificial clouds were employed.

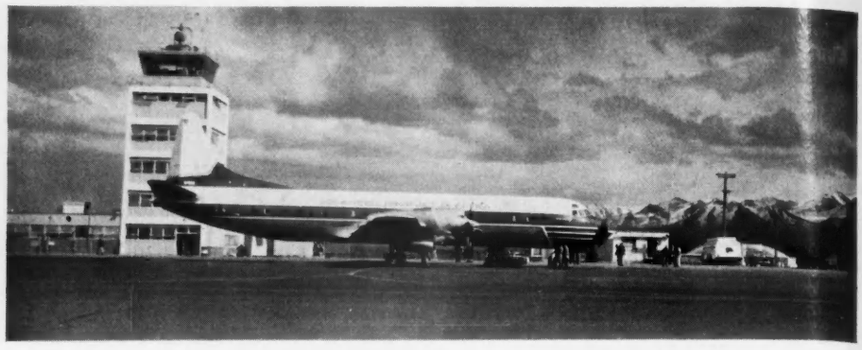


Fig. 1 The Lockheed Electra at Anchorage Airport, Alaska—looking for icing conditions.

Aerofoil surfaces of the Lockheed Electra are warmed with hot air bled from the last stage of the compressor in each of the four Allison 501 turbo-prop engines. Stainless steel pipes carry 550° F, 150 lb per sq. in air to compartments in the leading-edge. Mixing with cold air reduces the temperature to 300° F, which leaves the structural properties of aluminium unaffected. Fig. 2 shows a diagram of the installation. Each leading edge heat-transfer section is made up of a stainless steel duct, ranging from $\frac{3}{4}$ in to $1\frac{3}{4}$ in diameter. The duct is fitted with 0·050 in diameter nozzles, spaced forty to the foot. To save weight, parts of the stainless steel ducts also serve as manifolds for the pneumatic engine-starting system.

Airfoil ice protection is suitable for anti-icing or de-icing, but the engine inlet and duct system is designed only for anti-icing operation. The engine inlet duct lip and exposed internal surface are protected by a continuous-flow bleed-air system; as the surfaces are made of steel, air at 600° F is used. Spinner and propeller ice protection is by electric heating.

Ice protection of the Electra has been designed to meet the requirements of the USA Civil Air Regulations. Also, because the Electra may have military applications, the system has been designed to be compatible with military requirements. The design condition is shown in the table.

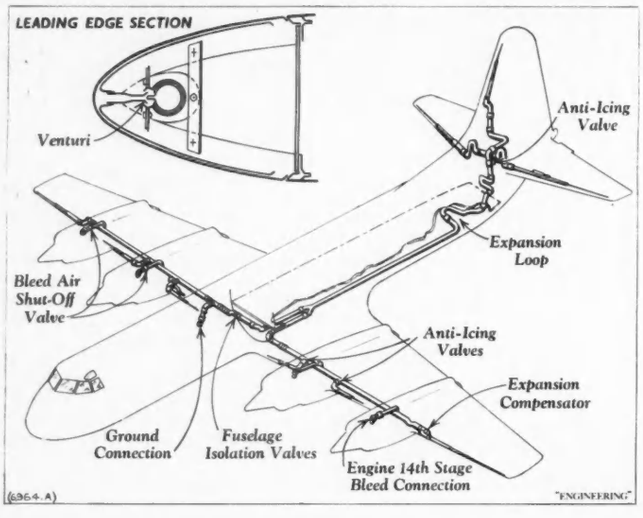
Design Point of Electra Anti-Icing System

Altitude	20,000 ft
Velocity	300 knots
Ambient air temperature	+ 15° F
Volume Median drop size	20 microns
Liquid water content	0·44 gram per cu. m

At the critical altitude of 20,000 ft the amount of bleed air available is minimum; the system has been designed to function between sea level and 30,000 ft. At the design point about 8 per cent bleed is required and an adequate flow can be maintained at 60 per cent of normal rated engine power—the usual descent power with anti-icing operating.

AEROFOIL REQUIREMENTS

Wing and empennage systems have been designed to evaporate all impinging water up to the icing conditions at the design point. Bleed air requirements are obtained by considering the energy balance between the external heat losses (convection cooling of the heated surfaces, evaporation of the impinging water, and sensible heating of the impinging water up to skin temperature) and the enthalpy drop of the air flowing through the double skin passages. In the equations setting out this energy balance, a "wetness" term was included to allow for the fact that water runs down the wing in narrow rivulets. Two methods of evaluating the equation were used: The first (Lockheed Report 8530) was a simplified graphical technique based on the assumption of a fully turbulent boundary layer from the leading edge, a free stream velocity (rather than a local velocity), and a uniform surface temperature. The second method was a point-by-point analysis by digital computer of the skin and air temperature distribution along the wing chord, using the airflow obtained from the first analysis. Eckert's wedge solutions were used to calculate laminar heat transfer. The boundary layer transition Reynolds number included an allowance for the effects of a favourable pressure gradient, and sensible heating was calculated using local impingement data. Local "wetness" was progressively reduced in order to account for upstream evaporation, and an allowance was made for the conduction which



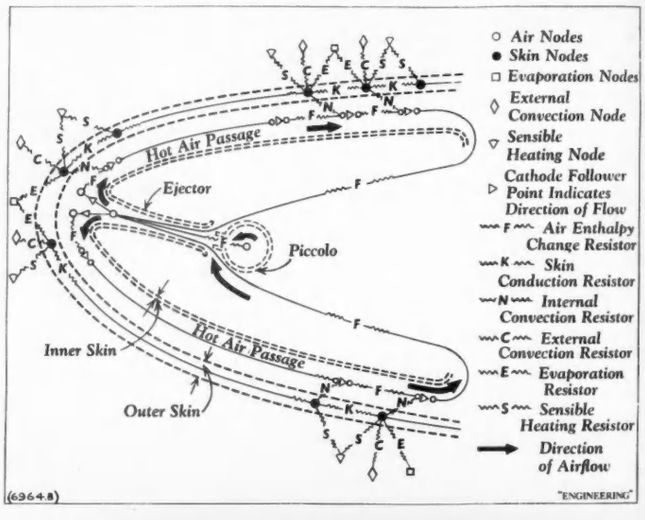


Fig. 2 (above left) Bleed air distribution system to the aerofoil surfaces—stainless steel ducting.

Fig. 3 (above right) Electrical analogue circuit used to compute skin temperature distribution.

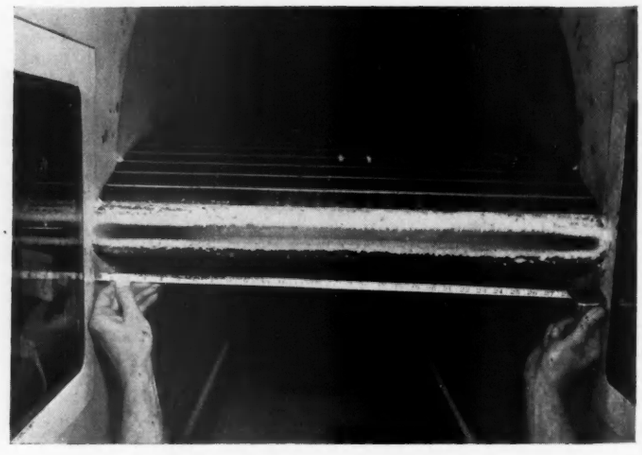


Fig. 4 (right) Aerofoil model in icing wind tunnel confirms analytical predictions.

occurs between the inner and outer skins.

The internal temperature drop of the hot air, and so the heat transfer rate, is controlled by the temperature of the mixed air entering the double skin passages and by the rate of airflow. The ratio of entrained to bleed airflow for the wing averages 1·8, but it is not easy to calculate the mixed air temperature. When a thermostat is controlling, the leading edge plenum temperature is predetermined but the weight-flow is unknown. The problem is solved by reiterative techniques. If, on the other hand, the weight flow is specified then it is necessary to reiterate the energy balance until the assumed plenum temperature matches the calculated value.

Calculations were done on an IBM 704 computer using an electrical analogue of the head balance. The type of network used is shown in Fig. 3. It was possible to allow for evaporation non-linearities very simply by numerically specifying the evaporation resistor as a function of surface temperature. Using the computer, the surface temperature and passage air temperature distribution was predicted for a typical wing section. From this distribution it was possible to compute the local evaporation rate and then integrate over the heated area. It was found that the evaporated rate equalled the rate of water collection and that this analysis yielded the same required airflow as was obtained by means of the simplified technique. Analysis of the engine inlet duct anti-icing system used the same energy relationships as were used for the aerofoils.

WIND TUNNEL ICING

In the company's icing research tunnel it was possible to obtain experimental verification of design predictions a year ahead of the Electra flight test programme. The thermostatic temperture control was developed at the same time. Two models were tested. The first (Fig. 4) was a full scale section of the tailplane (30 in span, 60 in chord); the second was an aerofoil section that contained an overwing cooling scoop, a wing leading edge access door, and an outboard wing section production joint. The first was used to compare air and skin temperature with results of analytical methods; the second to obtain visual data on heated areas which were difficult to analyse.

The icing tunnel programme showed that it is possible to predict system requirements accurately, provided bleed air conditions—temperature and pressure—are accurately known for each wing and tail station. These were therefore checked on a mock up of the ducting system. The test data again confirmed the predictions that were made.

Fig. 5 (right) A Constellation spraying a simulated icing cloud.

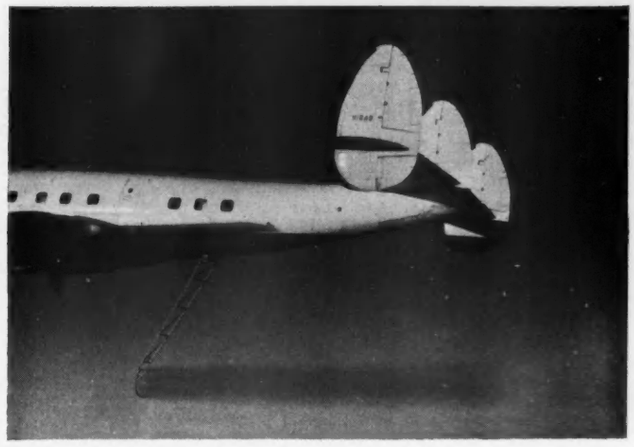
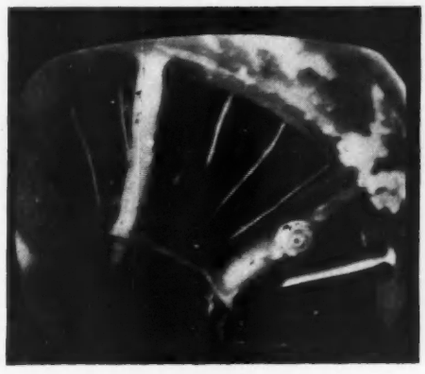


Fig. 6 (below) Closed circuit television enables study of engine inlet in flight during icing conditions.



FLIGHT EVALUATION

To include an icing evaluation in an extremely compressed certification schedule, three other aircraft were used in various early development stages. A 15 year old prototype Constellation with an Allison 501-D-13 engine nacelle in the starboard outer position was flown behind another old Constellation that had been temporarily converted into a water-spray tanker (Fig. 5). After refinement of the tanker icing simulation techniques and after observing engine behaviour in the simulated icing cloud by means of instrumentation that included closed circuit television (Fig. 6), further tests were carried out on a Constellation fitted with four Electra power plants. After brief testing behind the icing tanker it was sent to the mid-west, where it encountered natural icing conditions during late February and March. In this manner full confidence was gained in the Electra thrust system in icing conditions, and by April the Electra itself became active in the icing certification programme, see Fig. 1.

In the first series of tests, ice was allowed to build up on the wing and empennage and the airplane handling characteristics were investigated. The ice shedding ability of the leading edge system was then demonstrated: ice removal was complete within 16 seconds of control switch actuation. Removal was clean without any trace of runback freezing. Anti-icing was equally effective.

The pattern of development of the ice protection system in the Electra shows that the design of such systems can now be carried out on a reasonably scientific basis. By using analytical design procedures, development testing in laboratory and wind tunnel, and icing spray tanker methods, the need for extensive proof-testing in natural icing conditions is greatly reduced.

Closing the Control Loop with an Optical Instrument

Analysis of materials in an industrial process may often be carried out by an optical instrument. This might measure, for example, the refractive index of the material, or its effect on polarised light, or some aspect of the frequency response of the material to light. In the past, such instruments have produced a direct visual output examined by eye. Now electrical outputs can often be produced and digital or graphical outputs obtained. A further opportunity then arises: the possibility of using the output of the instrument to control the quality of the material, by some sort of feedback arrangement.

In a paper " Modern Developments in Optical Instruments," by J. H. Bach and G. E. Fishter (read before the Society of Instrument Technology) the authors discuss the problems arising in this development. They consider that the instrument industry is equipped to meet the challenge, but that it cannot do so by itself: " There must be a constant cross-feed of information between the instrument world and those industries which use the instruments."

To illustrate the sort of problems involved in bringing instruments hitherto used in the laboratory into industrial plant, the authors discuss a spectrophotometer. Both recording and non-recording versions of these instruments are used for laboratory analysis of multicomponent mixtures. But they are not suitable for immediate application to continuous flow monitoring.

The problem breaks down into one of measuring the amounts present of wanted components, say p in number; of unwanted impurities, say q in number; and of, say, r of unresolved, relatively harmless impurities. In any part of the spectrum—ultra-violet, visible, infra-red—the absorption spectra of each of the components will overlap to a serious extent. Only in rare cases will an absorption peak coincide with a zero-absorption point of the other constituents. The absorption spectrum of the mixture will in fact be the scalar sum of the $p + q + r$ absorption curves. Of these the p curve shapes will be known, the r curves may or may not be known, and the shape of the remainder will generally not be known.

Two ways of approaching the problem suggest themselves. One involves using the whole spectrophotometric curve, the other only uses a certain number of related points. Both require a full library of absorption curves for pertinent standards. The first method is theoretically sounder, particularly when the identity of any of the components is unknown or in doubt. But when in practice it is possible to derive an almost equivalent result by a sampling method, this is usually the economic thing to do.

The output of the spectrophotometer can be arranged in digital form to provide a direct input to a digital computer. The manipulation of the curves required involves a matrix inversion, and standard methods can be used. A punched-card or tape record of wavelength versus optical density is fed to the computer, together with the library information in a similar form.

The difficulties in providing a digital output vary greatly with the type of instrument considered and with the precision required. Each pair of values of wavelength and optical density is subject to instrumental variations, and additional errors will also arise from the readout system. When the number of components is large the computing problem becomes formidable and time-consuming unless a large installation is used. But, as mentioned before, it is possible in many cases to reduce the scale of computation. At a given wavelength a number of the components of a mixture can have appreciable absorption, while at a second, fewer of the components will have appreciable absorption, and at a third, fewer still, and so on. A computer programme based on this approach, with looping and comparison stages, can often lead to an appreciable saving in time. Neverthless, there are a large number of practical installations where this is not practicable. Thus, the real advantages offered by these instruments will not be obtained until the very severe sampling problems are solved.

Destroyer Rudder Flutter

Although flutter is usually associated with vibration violent enough to severely damage an aircraft, it can occur in other forms. A particular instance is in the rudder of a fast-moving ship. There the vibratory forces depend on the speed, but the stability of oscillation depends on damping which has both hydrodynamic and structural components. If as the speed increases the damping increases too, the build-up of vibration may be limited.

The importance of flutter below the region of instability (sub-critical flutter) to the field of naval architecture is stressed in a paper " Rudder-Excited Hull Vibration on USS Forrest Sherman (DD 931)," by R. T. McGoldrick (presented at the annual meeting, New York, November, 1959, of the Society of Naval Architects and Marine Engineers). The author considers that it is not safe for the naval architect to assume that control surface flutter phenomena are out of the range of ship operating speeds, even though the rarity of actual examples in the marine field—with the exception of the " singing " propeller—indicates that critical speeds are quite high.

Flutter is suggested as the cause of a peculiar type of vibration encountered in the USS Forrest Sherman. In the upper speed range a horizontal vibration of the entire hull at a frequency of 4 c/s occurred, regardless of propeller shaft speed. A cure for the vibration was achieved by giving the twin rudders a few degrees toe-out instead of toe-in.

The author suggests that under the initial 3° toe-in setting of the rudder, there developed at high speed a sub-critical flutter condition involving the coupling of torsional oscillations of the rudders with three-noded horizontal flexural oscillations of the hull; cavitation may have been present. The resulting reduction in overall damping increased the sensitivity of the rudder-hull system to the excitation at the bow which is always present when a ship is under way. As tuning of the torsional oscillations of the rudders varies both with ship speed and mean angle of attack, reversal of the toe angle detuned the rudders sufficiently with respect to the natural frequency of the hull to eliminate the sub-critical flutter condition. Hence the rudder-hull system was no longer sensitive in the mode excited previously.

A considerable programme of experimental and theoretical research was undertaken to examine the various aspects of flutter and vibration that might have had a bearing on the vibration experienced in DD 931. Study of the flow around the rudders was undertaken in the David Taylor Model Basin; it was shown that venting or aeration were not responsible for the vibration at speed. It was clear, however, that cavitation occurred and could fluctuate in step with the oscillation of the rudders and result in a self-sustaining hull vibration.

Flutter studies were made with a hydrofoil surface free to rotate in a tank towing carriage. No attempt was made to produce a model of the DD 931 hull system, but it was hoped that a method of flutter prediction could be developed for the simple surface and then applied to the ship case. The prediction was for flutter in the tank at 9·5 knots: subcritical flutter was found experimentally at 9·3 knots. At higher speeds the system became more highly damped.

To discover the vibrational modes of the DD 931 hull a 40,000 lb vibration generator was installed on the main deck directly over the propellers. The three-noded horizontal mode was found to have a frequency of 3·9 c/s, with an almost complete absence of a torsional component.

The experimental programme was backed with analytical calculation of the hull-response characteristics, using a UNIVAC computer. For calculations of the horizontal flexural modes, the rudders were replaced by an equivalent mass-spring combination. Each calculation was based on a particular value of the effective spring constant of the system, so representing a particular tuning of the torsional oscillations of the rudder. The analytical studies combined with the experimentally determined hull-response characteristics produced substantial evidence that the natural frequency of the rudders (with the ship dead in the water) were close to the frequency of the three-noded horizontal mode of the hull. Apart from the possibility of rudder-excited hull vibration, it appears that rudders introduce marked effects in the vibratory-response characteristics of the hulls.

Ship Propeller Pressure Field

Nearly all ship vibration is brought on by the propellers. The serious amplitude occurs at blade frequency (number of blades times revolutions per second). Generally, the vibrations can arise in two ways: by the action of the transient pressure field set up by the relative motion of the blades (" fanning ") with respect to the hull; and by the development of fluctuations in thrust and torque which arise from circumferential wake inequalities and are transmitted through the propeller shaft bearings. Calculation of the effects of the fluctuation in thrust and torque were made over a year ago. But only recently has a determined attack been made on the other component. This is the subject of a paper " Marine Propeller Pressure Field Due to Loading and Thickness Effects," by J. P. Breslin and S. Tsakonas (presented at the annual meeting, New York, November, 1959, of the Society of Naval Architects and Marine Engineers).

The study is limited to the fanning effect that would be felt by an observer at any fixed point in a uniform inflow near a rotating propeller—in the absence of hull and appendages. Formulae are derived and compared with experimental results obtained in the Taylor Model Basin. Comparison shows good agreement as regards variation of pressure with distance from blade tips, but is not so good as regards variation with axial distance. However, the qualitative result that the loading and blade thickness effects are in phase forward and out of phase aft of the propeller shows that the main characteristics are accounted for.

The paper contains sufficient material to give a conceptual grasp of the factors entering this important problem to provide a means of interpreting experimental data. Further theoretical research to find the effect of the nearness of the hull to the propeller, should eventually lead to a rational assessment of clearances, number of blades, etc., and so allow more confident design.

Multiple Engines for Vertical Take-off

" Is it not time that we cashed in on the lip service paid everywhere to the reliability of jet engines and depend on them for both legs and lift. They ought to be more reliable than undercarriage and flap systems. All that is necessary is the courage to go ahead." So concludes Mr. H. Pearson, chief research engineer, Rolls-Royce Limited, at the end of his paper " Engines for VTOL Aircraft," presented to the 7th Anglo-American Aeronautical Conference, New York. The author and his colleagues have mainly studied VTOL (vertical take-off and landing) as it would be applied to supersonic aircraft. They argue that requirements of safety and light weight both point to the use of a large number of small light engines.

The author suggests that for a large supersonic airliner the engines required for cruising—if aircraft shape is properly chosen for low supersonic drag—would provide only a fraction of the thrust needed for take-off; so that something like 70-80 per cent of the thrust/weight of the aircraft would have to be provided in separate lift engines. The concepts of VTOL aircraft considered in the paper are in the main those of the very narrow delta, in which the leading edges are swept back well behind the Mach cone. Such an aircraft seems to offer the advantages of low wave drag at the expense of only a small increase in friction drag, low structure weight with ample storage space, the necessary depth for stowage of lift engines, and the absence of flutter problems associated with thin wings.

A large reduction in weight/thrust ratio (or specific weight) is achieved by using several small lift-engines instead of one large one. The benefit is sometimes referred to as the " Square-Cube Law," because if an engine is literally scaled, then the airflow and thrust will vary with the square of the linear dimensions, whereas the weight will vary as the cube. The specific weight should vary directly as the scale factor. The simple rule assumes however that all dimensions will scale; in practice this is rarely so, as many are limited by existing manufacturing capability. A fair estimate is that nearly half the benefit of the square cube law is available without developing new techniques.

The author considers that small engines could be designed to be simple, cheap, and to have specific weights of at least 0·1. Design investigations show that, using knowledge of compressor and combustion chamber performance together with new constructions and materials—particularly plastics—it should be possible to achieve specific weights as low as 0·06. (The RB108 engines used in the Short SC1 VTOL aircraft have a specific weight of 0·112.) Thus the basic weight of lift engines promises to be of a rather similar order to present undercarriage weights. It is expected that this specific weight can be obtained with a thrust of 5,000 lb.

As far as safety in take-off and landing is concerned the author considers that a jet lift aircraft should be designed to be at least as safe as a typical four-engined aircraft. Owing to the use of multiple lift engines, failures of engines are more likely. It is therefore necessary to provide sufficient excess thrust so that with the remaining number of engines the aircraft can land safely.

A single engine failure is, of course, the most probable event. This would have to be accompanied by the shutting down of an engine on the opposite side of the aircraft so that balanced lift would be obtained; and the total amount of lift available must cater for this happening. In a study of a hypothetical aircraft in which the engines can produce 10 per cent more thrust in an emergency, the author concludes that adequate safety is given by between 16 and 20 engines. This is quite high in comparison with certain other projects that are under way.

Originally it was thought that engines would be grouped into sets of four, with a common fuel and oil system for each set. However, studies in lightweight fuel systems have progressed so far that it is probable that each engine could have its own system at no weight penalty.

XUM

On the Shelf

By Frank H. Smith

I am glad to think that the Islington Librarian reads this column since his October News-Sheet says " The world today, if we are to believe our television sets and radio receivers, contains an ever-increasing number of people, who if not actually omniscient are well on the way to being so." (In my own case I differ only with that statement qualifying the attribute.) This chatter is all a preliminary to selling the ability of Islington to supply all the answers—which is as it should be. Funny men (and women)—librarians. Give them an insoluble problem of information and they'll be as happy as a chick in a broiler house. All the same, some of these public librarians are getting a bit free with those tricks of the trade that help to make librarians pedestal-occupiers. Do it Yourself can go a bit too far.

Hardly had the first accident taken place on M1 when I found a well-produced book by L. T. C. Rolt (the engineers' historian?), published by Laing on " The London-Birmingham Motorway," on my desk. This, I feel, is a bit of snappy publishing but the production does not suffer for it is well printed, amply and well illustrated and altogether a delightful souvenir. (You can try for one, John Laing and Son Limited, 4 Regent Street, London, SW1.) American readers—M1 is our new super motorway where there's not a pedestrian in sight and motorists go stark staring bonkers (but not round the bend).

Among a basinful of literature from Collets' (44-45 Museum Street, London, WC1) is their " Library List " for winter, which lists a number of dictionaries, with of course (in view of the source), the accent on Russian. Especially specialist are library and bibliographical, motor and tractor, agricultural, automation and instruments, radio, railway, mining, shipbuilding. Looking through the list of other tongues I tend to wonder who wants Serbo-Croat or Slovene or Ukrainian.

According to " Aluminium News " (my copy comes from Northern Aluminium Company Limited, Bush House, London, WC2) the clink at Kingston, Canada, is providing the prisoners with aluminium mugs. They will be more attractive and less effective as weapons and breakout instruments. Why not go the whole hog and shape them like boomerangs? Seriously, though, this attractive little periodical often contains a snippet on some new development. That for October contains a technical note on aluminium 730 alloy, specifically designed for solid bearings.

If you have any interest in translations, you may like to know of " Customs Translation Club." As far as I can see it is a sort of mutual help body but the only way for you to get the whole story is to ask Consultants Custom Translations Inc., 227 West 17th Street, New York 11. Some sort of register comes into it somewhere also. Tons of Russian, of course.

If you wish to get the best out of your electronic data processing programme, Messrs. Canning, Sisson and Associates Inc., 1140 South Robertson Boulevard, Los Angeles, assure me that you cannot do better than invest in *Data Processing Digest* at $24 a year. But have a sample copy first.

When a man is co-author of a book with a title like *The Technical Writer* one tends to lose sight of the fact that he might also be a technical type. So it is with G. Parr who, in co. with O. H. Davie, is responsible for *The Cathode-Ray Tube* (Chapman and Hall, 50*s*). It would be worth buying the book if only to see if he conforms to his own standards. From the same publishers comes a free leaflet listing new American books on management. Prospective job-changers are catered for in *The Appraisal Interview* which, while it is for the man in the armchair behind the desk, might enable the hat-fidgeter on the other side to follow the working of his mind.

MAKING THE MOST OF MEN AND MATERIALS

The Landmarks of Tomorrow. PETER F. DRUCKER. *William Heinemann* (21*s*)

The Role of the Managing Director. GEORGE COPEMAN. *Business Publications Limited.* (42*s*)

Men Who Manage. MELVILLE DALTON. *John Wiley and Sons, Inc., New York; Chapman and Hall Limited, London.* (54*s*)

Any progressive epoch such as the fifteen years since the end of the Second World War has many features which can be cited as characteristic of its trend, and perhaps with equal right. This makes it difficult to select any one outstanding among the many, but it would not be untrue to say that, for the industrial scene in Great Britain, some claim in this direction can be made for the emphasis that has been placed on serious attention to the study and development of management. The claim would be justified if only by contrast with the very different position of the prewar situation. The scene then was characterised by lack of interest in the subject, or, at best where interest was aroused, by inconsequential argument as to whether any such skill as management existed distinct from the technology of the industry concerned, or from the enterpreneurial flair that was a feature of the successful business man.

The serious interest in management of the postwar years had its roots in war-time developments, where the needs of rapidly expanding industry, in face of shortages of equipment and manpower, made great demands on skills and techniques of planning and control. In the period of transition to peace-time enterprise, the setting was one of continuing and far-reaching dislocation, with equally continuing shortages of materials and labour, and above all a shortage of men ready to take over the higher levels of responsibility. The Second World War had been largely an industrial war, and the problems of transition to peace were equally markedly those of an industrial situation. There were men returning from the services accustomed to command in service parlance, but not accustomed to manage in the industrial sense. In this context it was inevitable that the little prevailing view of prewar years which had advocated the need for the systematic study of management should obtain a wider hearing and support.

The first practical step on the British scene was the appointment in 1946 of a Governmental committee to investigate the possibility of defining a national syllabus of management studies and establishing educational facilities to provide the necessary instruction. This indeed was a step unprecedented in Governmental circles, and even more unusual was the immediate acceptance of the committee's proposals in 1947, leading to the inauguration of a nationally wide system of management studies at numerous colleges of technology and commerce. In submitting its proposals, the committee's report pointed out among many obstacles to be overcome in the implementation of its objectives was one over which Government action could exert no influence, and the committee do little more than exhortation: namely, the shortage of serious literature round which to build the systematic studies. There were at the time numerous textbooks on the broad field of management practice, but most of them were of a general and superficial character giving elementary introduction to specific techniques as applied in certain limited fields, or broadly descriptive studies, with little of the serious academic standard of text commonly found in other disciplines. Nothing at all that could merit consideration as acceptable at the university level.

It was from America that the first major constribution came to fill this gap—in keeping with the spirit of the times when considerable activity was concentrated in sending to the States British personnel as " working parties " or study teams to learn the " know-how " of American industry. From the staffs of American colleges and industrial enterprises numerous textbooks were written covering every field of management practice, and they found their way readily to the British market. A limited number of British publications appeared, but there was no successor to the one classic of 1934 (Elbourne's *Fundamentals of Industrial Administration*) until nearly twenty years had passed: the British infilling continued to be in specific directions and of broad descriptive approach until the appearance in 1953 of *The Principles and Practice of Management* soon to become the acknowledged companion to its one classic predecessor. Other serious studies have appeared in later years, but the situation remains that the volume of British literature to support the systematic study of management in depth is scanty.

Three books have recently appeared on the scene, by coincidence about the same time, which are not untypical of the literature that has characterised the last decade. Of these one is British and two American; the three are complementary in their approach to the subjects covered, though not covering the same fields. Apart from a reviewer, he will be a brave man who reads all three! They may be held to represent roughly three different points of view—those respectively of the philosopher, the practitioner, and the social scientist. Each author shows in his own way wide knowledge and understanding of management in his own setting and the first two have become well known in the management world on both sides of the Atlantic.

Peter Drucker, enjoying a high reputation in management literature, has written in *Landmarks of Tomorrow* the seventh of his management studies within a period of ten years. The earlier ones were at once descriptive, analytical and critical of the industrial scene, looked at particularly from the standpoint of management in the larger enterprises. The later studies tended to display a philosophical attitude in the presentation of theses, and in this, the latest of his works, the philosphical penetration is carried to considerable depths in a search for basic objectives of the industrial system towards which management can direct efforts with some degree of satisfaction in attainment. These objectives Drucker finds on the social plane, in a two-fold pattern which may be broadly described as the well-being of the citizens at home and the progressive amelioration of the underdeveloped countries abroad. But in his ardent pursuit of these objectives, he remembers that our industrial system is based on " free enterprise " so that social purposes must be served only in the context of a parallel urge to " profit "—for it is the latter which provides the motive power of the system. One of the most illuminating paragraphs is an almost passionate apologia for profit.

Drucker's study starts with a consideration of the social consequences of innovation looked at from a technical and a sociological standpoint. By innovation Drucker means " man's attempt to create order in his own mind and in the universe around him by taking risk and creating risk." The technical aspects of innovation are self-evident from the inventions and mechanised advances of the past century, but the social aspect is something new to our own age—the newly acquired capacity to organise activities on a large scale to given ends which can be pursued systematically, purposefully and effectively. The first half of the book is an exposition on these lines of thought, accompanied by a commentary on historical comparisons to mark the contrast between the present and the past. One wonders, in the event, whether the author has not over-

Continued on next page

dramatised the nature of the contrast: " No one born after the turn of our century has ever known anything but a world up-rooting its foundations, overturning its values and toppling its idols; no one younger than this century has known anything but an age of revolution." Dramatic words which may arrest the American citizen, but they ring hollow in the traditions of Europe!

Consideration of social innovation in the shape of large-scale organisation leads inevitably to consideration of the role of the manager, to the ever-growing importance of that role, and to a resumé of the features which characterise it. This enables the author to turn in the second half of his book to the fundamental problems that he has set out to study: namely, the absolute prerequisite of education for ensuring the competence of the manager and through management for attaining the much required economic development. " Finally," he writes, " it is the new organisation that is the engine of economic development. The ability to organise men for skill and knowledge is the basic resource of economic development . . . An abundant and increasing supply of highly educated people has become the absolute prerequisite of social and economic development in our world." He has been able in his examples to make this clear in the setting of the underdeveloped countries, but how the pursuit of the free enterprise motive of profit can be effectively geared in with the basic social objectives remains an unresolved problem for the established industrial society.

The book is typical of Drucker's later works, in its confused objectives, its repetitive presentation of thoughts, its overwordiness, its tangled skeins of ideas, motives and conclusions. Yet this does not make it the less worthwhile as a serious study in keeping with the trend of thinking of our times, and valuable to any manager who is ready to invest brain-time in the advancement of his professional standing.

When we turn to the practitioner for the second of the three studies, we meet an author who hails from the British scene and is already known for two or three companion studies which have preceded this one. In striking contrast to Drucker, Copeman finds his delight in presenting realistic descriptive notes reflecting very practical facets of the management process actively at work in the daily lives of men. He approaches his material on the basis of personal contact by questionnaire and discussion with the aim of exhibiting snapshots of the art of management, adding the third dimension by describing for his reader the reactions of those managers he has visited. The title of the book could well be misleading, for it might suggest a study of what the managing director should do and how the job should be carried out: instead it is the digested results of thirty interviews presenting a series of individual cases looked at one by one in a classification of the many activities which by common acceptance would be covered in the chief executive's role. The snapshots seem at times to be taken with an unusually long-range lens!

The book is undoubtedly useful to many business men, and is likely to find its best readership among the established executives who are seeking a " check list " of items to test their own activities; or perhaps to glimpse how other people perform, so as to give themselves a warning against possible pitfalls and a guide to likely improvements. An interesting innovation in the study is the fourteen page summary at the outset of the book, giving some dozen lines on the content of each chapter: this makes possible a quick absorption of the main lines of thought on each subject covered, and forms a ready reference to the material which forms the snapshots in the detail of the chapters themselves. These are mainly in personal style: that is, a brief portrayal of how Mr. X does this or Mr. Y that, and between the cases the author makes his own commentary, sometimes attempting to answer any specific questions in the case material and sometimes pointing to other lines of approach that might be studied in respect of the particular activity of the man he has quoted. This method of treatment gives a living character to the material presented, but inevitably makes for a degree of superficiality in the treatment. While not minimising in any way the value of the book to many people in the management field, it must be admitted that the publication has a somewhat limited value to the serious student. From this standpoint it contains a handicap to real learning, because of the difficulty of inter-relating the various items of material arising under different headings (that is, in different chapters) from the experiences of the thirty men whose practices have provided the bulk of the content. The author claims this as a special merit of the study —" showing what managing directors have actually said and what they actually do," on the basis of the reporter's technique. But there is also the observation that " some of the things reported by managing directors may be partially wishful thinking."

The third book, again of American origin, is a study of an entirely different order. Its main title, *Men Who Manage*, suggests something of the practical man's guide not dissimilar from Copeman's, but the wording of the subtitle (" Fusions of Feelings and Theory in Administration ") reveals the very different nature and approach of the book, a penetrating study by an author who is a professor of anthropology and sociology. Being of American origin, the book is detailed, complex and comprehensive, less a descriptive study than a systematic, analytical reivew of case material. There is adequate description relating to the three or four firms round which the sociological analysis is built up, but the fact that it has twelve pages of bibliography, as well as some fifteen or twenty documentary notes as an appendix to each chapter, gives a correct indication of its author's treatment of his subject-matter. This study is in the nature of a parallel, on a company scale, to the Mayo work in the Hawthorne investigations of the 1930's or the British studies of the Glacier Metal Company. It is not as scientifically thorough-going as these, but it is an equally penetrating review of the situations studied and critical appraisal of the human tangles which emerge. Whereas Copeman's book is one to be browsed through, dipped into, read at leisure, picked up for guidance on specific points, and otherwise used to advantage in somewhat lighter vein, Dalton's volume can be appreciated only by being systematically and seriously studied. In fact, to get a full appreciation of the case material presented it is necessary to carry in one's mind a great deal of the factual material describing the positions, the background, and the numerous incidents surrounding the people featured in the studies.

The scope of treatment is all-embracing in the types of problems that it covers within the realm of interpersonal relationships—including conflicts, politics and power struggles, the formalities and nuances of staff and line, the influences of career ambitions, and the interweaving patterns of formal and informal relationships.

The serious reader emergies from this text with a somewhat different picture of the average American business from those that have become the classics of efficiency and good methods. The author has emphasised that the firms covered by his cases are representative of American industry in a broad sense, but many of the situations described and analysed by him would make it impossible for any British managers to continue being " starry-eyed " about their American counterparts if this case material is characteristic. Some of the situations, in fact, go so far as to leave one wondering whether anything of real value comes out of the very widespread management training that we have in Britain learned to see as a normal feature of the American industrial scene. Perhaps the author is forestalling our misgivings when in one of his later chapters he comments that " the typical firm is a shifting set of contained disruptions, powered and guided by differentially skilled and committed persons . . . the battle between impersonal organisation and the personalising individual is old." In this context, chapters 6 and 7, dealing respectively with " the managerial career ladder " and " official and unofficial rewards " afford and indeed virtually call for a comparison with the somewhat similar studies of Copeman partly portrayed in the foregoing book but more fully dealt with in his earlier publications.

Any manager-reader who has struggled through these three books would come away from them partly bewildered and perhaps overwhelmed: in many cases he would not recognise himself in any one of the pictures that have been differently presented by the authors—neither in the daily job he finds himself called upon to do, nor in the team working with which he would be normally associated, nor in the comradeship which he would have expected to find built up in the course of working associations with colleagues. The first and third of these publications contribute to the sociological thinking that we have learned to accept as typical of American management authorship, but they lead us to recognise how little we really know about the substance of management practice, despite the claim of so many people to earn a worthwhile living by reason of the competence with which they carry out its requirements. This thought perhaps leads back full cycle to the realisation also that, despite the progress of the postwar decade, there is still a long way to go along the road in pursuit of serious study of this management practice.

E. F. L. BRECH

NEW BOOKS

La Théorie Physique au Sens de Boltzmann. By RENE DUGAS. Bibliothèque Scientifique, 33. *Editions du Griffon, Place de la Gare, La Neuveville, Switzerland.* (32 *Sfr*)

The author who died in 1957 was one of France's foremost historians of science.

Journal of the West of Scotland Iron and Steel Institute. Volume 66. *The Institute, 39 Elmbank Crescent, Glasgow.* (47*s*)

Contains the introduction, seven papers, discussion and bibliography of the Conference on metallurgical and engineering aspects of weight-saving in steel structures, held in May, 1958.

Theory of Machines Through Worked Examples. By G. H. RYDER. *Cleaver-Hume Press Limited.* (21*s*)

A third edition thoroughly revised in view of modern requirements. Aimed at Higher National and " Mechanicals " diploma. The author is a principal lecturer at Shrivenham.

TRADE PUBLICATIONS

Copies of any of the following trade publications are obtainable from the addresses given, though distribution is sometimes restricted.

Staging. ACCESS EQUIPMENT LTD., Maylands Avenue, Hemel Hempsted, Herts. Zip-Up staging for maintenance and general work. Folds to flat units when dismantled. Heights to 100 ft., fully mobile. Illustrated catalogue.

Fire Protection. ALBI-WILLESDEN LTD., 6 De Vere Gardens, London, W8. Albi-R fire retardant coating for most surfaces. Applied as a liquid gives Class I protection. Fully certificated. Various colours available. Folder.

Passenger Lifts. MARRYAT AND SCOTT LTD., Wellington Works, Hounslow, Middlesex. Standard range of passenger lifts up to 3,500 lb load. Illustrated leaflet.

The Reviewer

Mr. E. F. L. Brech is a senior partner of Urwick, Orr and Partners. He is author or editor of several books, including *Management: Its Nature and Significance*, *The Principles and Practice of Management*, and *An Introduction to Foremanship*. He is a fellow of the British Institute of Management, and was founder chairman of the Association of Supervisors' discussion groups, and founder director of Management Selection Limited and Urwick Diebold Limited.

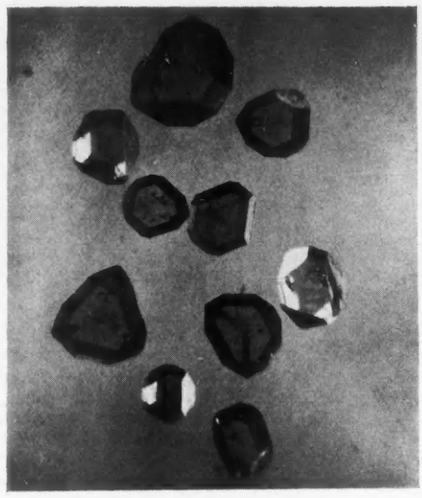
Diamonds Made Quickly with Metal Catalyst

Manufacture of man-made diamonds was first announced by the American General Electric Company in 1955. This was followed two and a half years later by commencement of pilot plant production in 1957. Now the US Government secrecy on this process has been removed, and General Electric announce the process. Basically it is one of catalysis, using a metal activator which speeds up the process of transforming graphite to diamond, and allows it to be done at "low" pressures and temperatures—over 800,000 lb per sq. in and 2,200° F.

The catalyst metal can be chromium, manganese, iron, cobalt, nickel, ruthenium, rhodium, palladium, osmium, iridium or platinum—so there is quite a choice. Tantalum is said to be particularly effective for inducing the growth of small crystals although it is not always the most active. This catalyst forms a liquid metal layer between the carbon and the growing diamond crystal. Without the catalytic action it is estimated that pressures of 3,000,000 lb per sq. in and temperatures of over 7,000° F would be required.

General Electric have discovered that the new diamond can form whether a diamond seed is present or not, and that diamond can grow at very high rates. The formation of man-made industrial diamonds (80 mesh and finer) is completed within a few minutes. Diamonds of such size can be used in grinding wheels, which are the main outlet, so they have found a ready market in the United States who, with a consumption of 2 tons a year, have no important natural domestic source. The process has been so highly developed that the price of synthetic bort is only slightly greater than that of the natural product.

Synthetic diamonds have advantages over natural, although they are limited in size to 80 mesh and finer, or up to 60 mesh if an aggregate or cluster is acceptable. Tests by Carborundum Company in the United States have shown that the more irregular surface of the synthetic diamonds gives them a firmer bond in a resinoid wheel. Together with the different cutting surfaces displayed, this can give a higher life of wheel, and Carborundum quote an example where in wet grinding of tungsten carbide, the life, or amount of carbide removed for a given weight of bort, was increased 64 per cent.



Synthetic diamonds: the company making them in America has not only found that when used in grinding wheels they are often better than natural bort, but also that it is possible to tailor-make the crystal structure into different forms for different grinding purposes.

General Electric, speaking of their recent discovery, say that they can tailor diamonds to the shape they want. Apparently the shape depends on the temperature of formation (maximum is 4,400° F). Cubes predominate at the lower end of the critical temperature range; mixed cubes, cubooctahedra, and dodecahedra at the intermediate point; and octahedra at the upper limits.

The nature of the starting material used to supply the carbon has some effect on the kind and number of the diamonds formed. The best results are obtained with substantially pure graphite. Other carbonaceous material, such as carbon black, sugar charcoal, or carburising compound, may be used as the source of carbon but not with such good results.

Several devices were invented by the General Electric scientists for sustaining the ultra-high pressures and temperatures required to change carbon into diamond. One very successful device, called the "belt" by its inventor, makes use of conical, Carboloy cemented-carbide pistons that push into each end of a specially doughnut or "belt" shaped Carboloy cemented-carbide chamber. The conical piston has much greater strength than the usual cylindrical piston of high pressure equipment. Both chamber and pistons receive support on all sides from a doughnut-shaped structure consisting of several stressed binding rings, from which this device takes its name.

A very important feature of the "belt" is its pressure sealing technique. In this method, conical gaskets of pyrophyllite, a naturally occurring form of aluminium silicate, are used for the dual purpose of holding pressure and yet allowing motion through compression and flow. A unique characteristic of pyrophyllite is that its melting point is raised from 2,400° F to 4,800° F by pressure. Pyrophyllite is also used to hold the sample, which consists of the graphite and the metal catalyst. The high temperature is obtained by the passage of electrical current through the sample. The pyrophyllite, in addition to transmitting the pressure of the converging pistons, serves as a thermal and electrical insulation, enabling the pistons to remain comparatively cool, thus increasing their effective strength and extending their useful life.

Glassed SG Iron Fittings

Glass coated steel and cast iron are widely employed in the chemical producing industries where near perfect corrosion resistance at high temperatures and pressures is required. Pfaudler glass lined pressure vessels have been made for years. Now, the Pfaudler associate company in the United Kingdom, Enamelled Metal Products, of Leven, Fife, have perfected techniques for coating ductile or SG cast iron with glass (vitreous enamel), and they are currently commencing manufacture of fittings made therefrom. British and foreign patents are now pending for this application.

While SG iron casts with the ease of grey iron, it possesses working properties similar to steel, and these are retained after the process of glassing. Strength is 2½ to 3 times greater than that of a glassing cast iron, and this is clearly shown in the illustration, together with a comparison of elongation. Properties are also attractive when compared with glass coated steel plate. Thermal shock resistance is improved; 80 per cent better than glassed grey iron, in fact. At normal operating temperatures, components made from the new material can safely be subjected to sudden shocks of 180° F compared with 100° F for the old.

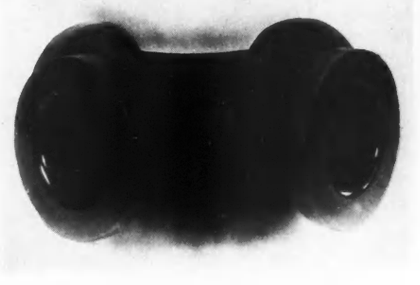
To date, the complete absence of ductility in grey cast iron has imposed limitations on its use in fittings. This has applied particularly in the petroleum industry, where failure can lead to fire hazard. Many cases arise where insurance companies refuse to accept this material. SG iron with its superior yield strength and ductility is therefore coming into more extensive use.

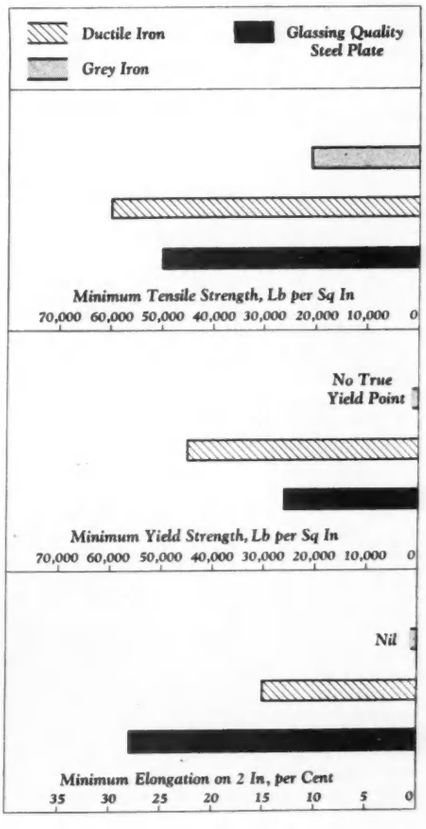
The glass coating is still, of course, brittle, but it is interesting to note that SG iron also has a higher modulus of elasticity than flake graphite grey irons (25×10^6 compared with 18×10^6 lb per sq. in) so with the same applied stress or rate of impact, the new material can stand up to more than the old before cracks appear in the glass coating. Even after the onset of cracking, a great deal of strain can occur before fracture of the SG iron.

A typical fitting made by Enamelled Metal Products is shown in the illustration. In America they are already being offered by Pfaudler as elbows, tees and crosses in weights up to about 100 lb, but in this country the company is not anxious to commit itself to any hard and fast range of sizes.

(Right) Mechanical properties of SG iron compare favourably with those of steel and grey iron.

(Below) Typical vitreous enamelled SG iron fitting: a 3 in diameter crosspiece.




Ductile Iron
Grey Iron
Glassing Quality Steel Plate
Minimum Tensile Strength, Lb per Sq In
70,000 60,000 50,000 40,000 30,000 20,000 10,000 0
No True Yield Point
Minimum Yield Strength, Lb per Sq In
70,000 60,000 50,000 40,000 30,000 20,000 10,000 0
Nil
Minimum Elongation on 2 In, per Cent
35 30 25 20 15 10 5 0

New Rubbers for New Hydraulic Fluids

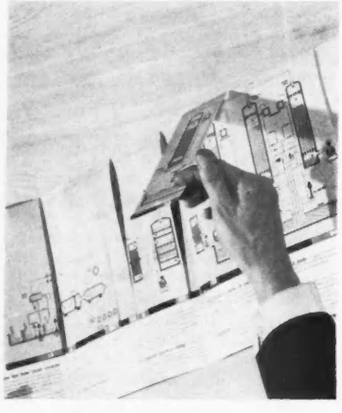
Skydrol is the name given to two hydraulic fluids which have been introduced recently for the equipment on aircraft—especially for undercarriage mechanisms. Made by Monsanto Chemicals, and launched with a wide sales campaign, they have one big advantage—non-inflammability; these ester-based fluids also have one big disadvantage—they have demanded new rubbers to resist them. The demand has now been satisfied by Precision Rubbers, of Bagworth, Leicester, in a number of new butyl synthetic rubbers which are all sold under the name X213X.

Within the butyl-X213X category are really three groups which combine various values of volume swelling in Skydrol, recovery from compression, and heat resistance. Typical hardness in the first group is 83° BS. The volume swelling in Skydrol 500, the fluid used most widely in the UK and now carrying a modification, is low—16 per cent at 100° C—and recovery from compression at 25 per cent strain for 24 hours at 100° C is not outstanding at 29 per cent, but at 70° C is satisfactory.

A typical grade in the second group of similar hardness shows a higher swell, 35 per cent, but the recovery after compression at 150° C for 24 hours is over 90 per cent. The third group is designed to give the same swelling as the first group with compression recovery values at 150° C around 80 per cent. The second and third group compounds have substantially improved heat resistance and over 70 per cent of the tensile strength is retained after 6 hours at 200° C, which is in any case above the working temperature of the fluid.

Designing for Sulphuric Acid—with Flaps

There are over 750 variations obtainable on sulphur burning sulphuric acid plant, so say Chemical Construction (GB) Ltd. Their solution to taking the headache out of designing such a plant is embodied in a new piece of sales literature which this firm has now released, shown open in the illustration. The person here is considering details of the oleum tower which may or may not incorporate a pump tank.



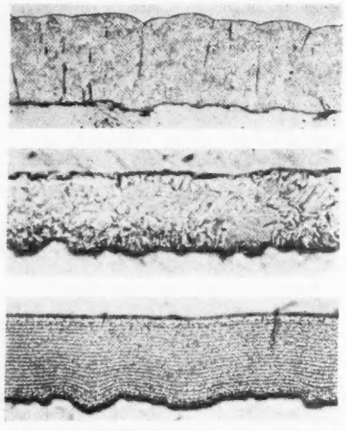
Specially laid out units provide a continuous flowsheet whatever choice of individual parts is made.

Starting at the beginning, one encounters a choice of sulphur melting pit or tank with or without sulphur filter, the latter being required, we are told, "if impure sulphur of high solids content is the raw material." The next nine stages through the whole plant concern the furnace, waste heat boiler, gas filter, heat exchanger, converter, economiser, oleum tower mentioned above, absorption tower, and finally dilution equipment. A quick calculation of the number of permutations yields $2 \times 1 \times 2 \times 2 \times 1 \times 3 \times 2 \times 3 \times 2 \times 2$ which unfortunately equals 576 and not over 750 as the firm say. However, this method of presentating information to technical and non-technical men should still be both interesting and useful—the latter is what it is meant for incidentally. Chemico, of 9 Henrietta Place, London, W1, add that this should facilitate installation of both new equipment and modifications, if only as a basis for telephone discussions and preliminary correspondence. Universities, they think, would find value in this kind of brochure for educational purposes. Certainly it was a success with the present writer.

Copper Plating on the Level

Du Pont in the United States have taken the irregularities out of copper plating with a new process which depends for its action on reversal of the plating current. A cross-sectional photomicrograph looks like the lower illustration, and this may be compared with the columnar structure of conventional plates and with the amorphous structure of the Du Pont process in which the current is interrupted.

The baths from which such coatings may be obtained are of high efficiency cyanide, but special levelling additives have been developed



0·001 in of copper plated on polished steel of 24RMS finish (× 500 magnification). Top, conventional plate; middle, interrupted current; bottom, current reversal.

which now parade under the names Elchem 1396 and Elchem 1442M. The cost of plating and the total time taken to lay down a given thickness increase, of course, as more copper is removed during the current reversal. For maximum levelling, Du Pont, of Wilmington 98, Delaware, recommend a cycle of 60 seconds plating and 20 seconds deplating, which with constant current means a doubling of electricity cost and time compared with d.c. The electrolyte must be agitated.

No Rust with Silicone Antitracking Fluid

Just the job for plugs and sockets. A new addition to the range of products marketed by Amber Chemical Company Limited, of 11A Albemarle Street, London, W1, may be described as being composed of a silicone based antitracking fluid containing a rust inhibitor. Silicones, incidentally, are usually more stable than ordinary oils, and because the carbon content is mostly replaced by silicon, they are not so prone to carbonising and tracking.

Electrospray, as the new product is called by Amber, is packed in an aerosol container. In addition to use on aircraft cable plugs and sockets where "it has already been found ideal," it is recommended for electrical equipment generally, where this requires good surface insulation under high humidity conditions. Being silicone based it is inert and water-repellent, among many other family attributes.

Paints for Damp Plaster and Perishing Distemper

Water-based latexes have caused quite a stir in the last decade and with their ease of application by brush or roller have encouraged large numbers of people to do-it-themselves. A. Sanderson and Company, of Hull, have now come out with a new water paint based on p.v.a., which adds to their range of emulsion paints, flat oil and gloss paints. This latest one has been designed for use on new plaster which can be still damp at the time of application. Moisture can pass through without affecting the film and there is no danger of damage by alkali.

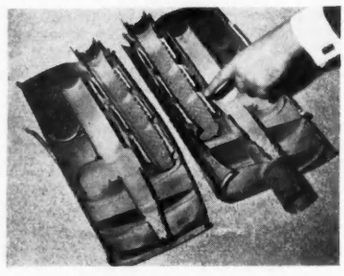
The makers say that many more coats of the p.v.a. can be applied one on top of the other than with normal oil-bound water paint, which may require the use of a binder or an oily primer to prevent flaking.

Now to the perishing distemper. P.v.a. is again included in a pigmented sealer which, with the incorporation of a penetrating oil, has been designed for treatment of weathered cement paint, flaking distemper and other underbound surfaces. Its name is Kinseal. This should be useful for sealing weathered cement paint which can be very difficult to remove from a rough surface.

Stainless Silencers May Pay

Whether it is called a silencer or a muffler, that necessary accessory for the motor car is noted for the brevity of its life. In America, the high power of the average car makes things even worse. The results of a test on a stainless steel silencer, made in the United States by the Walker Manufacturing Company of Detroit, were therefore awaited with interest.

After 30,000 miles of stop-and-go driving in Detroit, the silencers were removed and split in half for thorough examination. The illustration shows the condition—all tube slots were still clear and in perfect working order. The test



American "muffler" made in stainless steel after 30,000 miles driving.

silencers were of standard American design and were fabricated from the same gauge stainless steel as used in currently available mufflers made of carbon steel. Under similar driving conditions to the 30,000 miles in Detroit the makers say that conventional mufflers would certainly not have survived the test.

The stainless steel used throughout the silencers, with the exception of the headers and cup-shaped baffles, was type 430 an 18Cr-10Ni-2Mn alloy. The latter parts, which required more severe drawing operations, were formed from type 302, a 1·1 Mn-0·5Mo stainless alloy. The success of these first silencers in tests which took two years has prompted the manufacturer to make further ones in lighter gauge sheet.

Stirring Power Parameters

Because it is difficult to apply the principles of fluid dynamics to the design of mixers and stirrers, a part-graphical method has been developed by the Sadi Engineering Co.

The practical application of the theory of fluid dynamics is very difficult and many industrial problems find a satisfactory solution only through extensive experience or through research.

The case of mixers and stirrers illustrates perfectly this difficulty. Research workers have tried for more than 30 years to free from empirical laws the technique of motorisation of mixers, and have had to carry out many calculations, in an effort to establish the laws their design.

As the result of experience gained in equipping thousands of stirring devices, Sadi Engineering Company Limited, 10 Ansdell Street, Kensington, London, W8, have developed a method which they have set down in their magazine *Motorization*, No. 9. They point out, however, that it is merely an estimate of the power and the results are only approximate.

Some details from this interesting article entitled " Practical method for the estimation of the power consumption of paddle stirring devices," are given below.

Most of the many different types of stirring device in current use, are of the paddle type and Figs. 1 to 7 represent a few classical varieties. In each case the paddle is an element symmetrical to a normally vertical shaft. This element is generally made up of two blades (Figs. 1 and 6) but can also have 3 and 4 (Figs. 4 and 5), or even more. The blades are mostly rectangular, solid and fixed to the shaft, but other shapes are found (Figs. 8 to 11) such as, segments of circles, anchors, frames, forks, and so on. When the ratio between the height and the diameter of the rectangular solid approaches unity, the device is known as a " leaf " type mixer or agitator (Fig. 7). When an agitator carries several paddles mounted on the same shaft, the blades can all be in the same plane (Fig. 2) or in different planes (Fig. 3).

There are also agitators with blades inclined (in relation to the shaft) at an angle that sometimes reaches 45° (Fig. 6), in order to create agitation in the liquid mass towards the top or bottom of the stirring tub.

Experience shows that the power consumption of a blade agitator is proportional to:

(1) the specific gravity of the liquid;
(2) the height of the blade;
(3) the fourth power of its diameter;
(4) the cube of its speed of revolution.

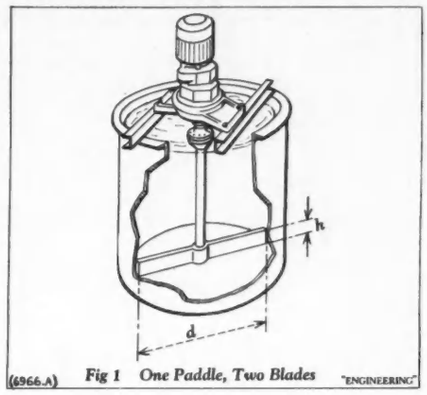


Fig 1 One Paddle, Two Blades

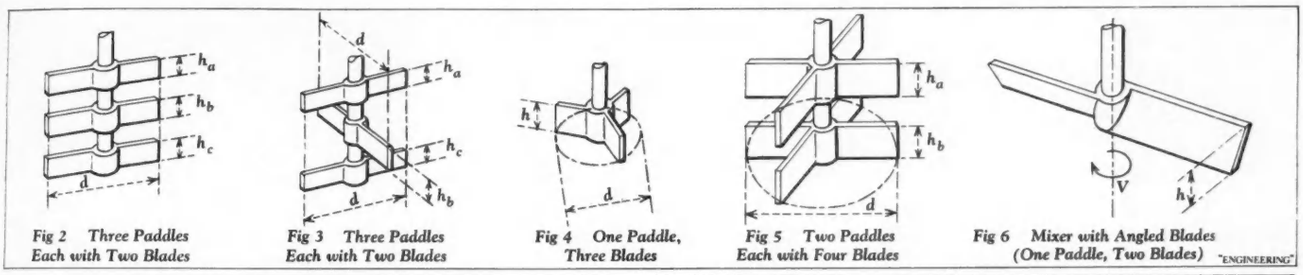


Fig 2 Three Paddles Each with Two Blades

Fig 3 Three Paddles Each with Two Blades

Fig 4 One Paddle, Three Blades

Fig 5 Two Paddles Each with Four Blades

Fig 6 Mixer with Angled Blades (One Paddle, Two Blades)

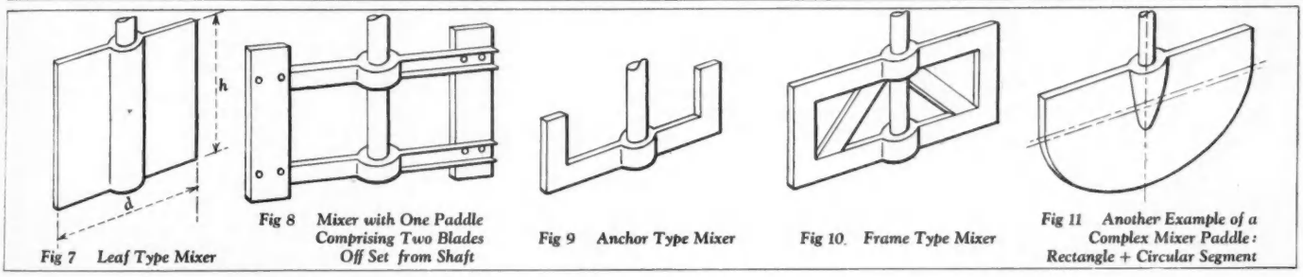


Fig 7 Leaf Type Mixer

Fig 8 Mixer with One Paddle Comprising Two Blades Off Set from Shaft

Fig 9 Anchor Type Mixer

Fig 10 Frame Type Mixer

Fig 11 Another Example of a Complex Mixer Paddle: Rectangle + Circular Segment

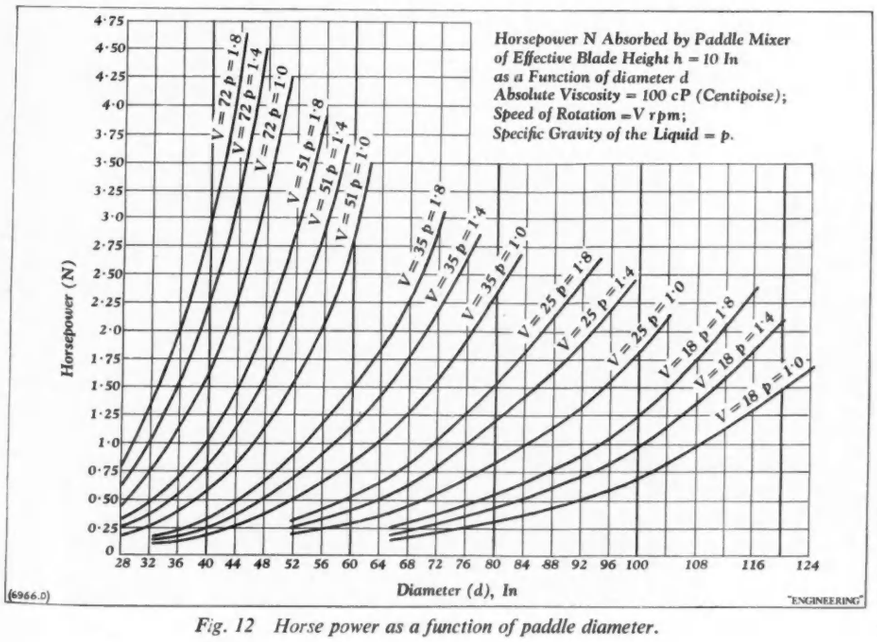

Horsepower N Absorbed by Paddle Mixer of Effective Blade Height h = 10 In as a Function of diameter d
Absolute Viscosity = 100 cP (Centipoise);
Speed of Rotation = V rpm;
Specific Gravity of the Liquid = p.
V = 72 p = 1·8
V = 72 p = 1·4
V = 72 p = 1·0
V = 51 p = 1·8
V = 51 p = 1·4
V = 51 p = 1·0
V = 35 p = 1·8
V = 35 p = 1·4
V = 35 p = 1·0
V = 25 p = 1·8
V = 25 p = 1·4
V = 25 p = 1·0
V = 18 p = 1·8
V = 18 p = 1·4
V = 18 p = 1·0
Horsepower (N)
4·75
4·50
4·25
4·0
3·75
3·50
3·25
3·0
2·75
2·50
2·25
2·0
1·75
1·50
1·25
1·0
0·75
0·50
0·25
0
28 32 36 40 44 48 52 56 60 64 68 72 76 80 84 88 92 96 100 108 116 124
Diameter (d), In
(6966.D)
"ENGINEERING"

Fig. 12 Horse power as a function of paddle diameter.

Three graphs (one of which is reproduced here in Fig. 12) and many worked examples are given in the original article, to which the reader is referred for full details. Measurements carried out on agitators in service in different industries have shown the graphs to be correct.

In explaining the method of using the graphs, emphasis is laid on these points:—

(1) The shape of the agitator. The method relates directly to agitators with rectangular solid paddles, fixed to the shaft at right angles, or inclined, no matter how many paddles or blades there are. If the paddles differ from this classification, they have to be reduced to an equivalent shape.

(2) Viscosity. It is, of course, necessary to use the graph that corresponds to the absolute viscosity of the fluid concerned.

(3) Specific gravity-speed. Choose the curve corresponding to the specific gravity of the fluid and the desired speed.

(4) Diameter of blade. The power is read off for the appropriate diameter (*a*).

(5) Height of blade. The power read on the graph is for a blade 10 in high. This value is factored down to suit the actual height.

(6) Supplementary coefficients. The value so far obtained for the power has to be multiplied by a series of coefficients to which are governed by the roughness of the inside wall of the tub, the efficiency of the driving unit and other factors.

Cycloidal Propellers give Ferry Manoeuvrability

An interesting design feature of the British Railways passenger and motor car ferry MV "Freshwater" built by Ailsa Shipbuilding Company Limited, Troon, Ayrshire, and recently commissioned, is the two Voith-Schneider cycloidal propellers, one located forward on the port side, the other aft on the starboard side. The ship has no rudder and all manoeuvring is accomplished by means of these propellers. Each propeller has four blades of aerofoil section, the axis of rotation being approximately vertical. Only the blades are immersed in the water; all the other parts are housed within the hull.

The principle of operation can be seen from Fig. 2 which is a diagrammatic plan view of a typical Voith-Schneider rotating propeller with the four blades located on a runner rotating contra-clockwise about O. The blade shafts are linked inside the runner to a spigot ring connected to an adjustable control point N. If N is at the centre O (Fig. 2 shows this condition), all the blades have zero incidence and there is no resultant thrust in any direction. When point N is moved to the left, and the rotor is in the position of Fig. 3, blade A has a positive incidence and blade C a negative incidence, but blades B and D still remain at zero incidence. There is thus a net thrust (as indicated by the arrows) propelling the craft forward. The value of this thrust (and hence the speed of the vessel) depends, of course, on the offset of N to the left of O. As the runner now rotates, the incidence of each blade automatically changes progressively from maximum incidence to zero incidence (or vice versa). To show this, the path of blade A is plotted for a series of eight positions (A_1 to A_8 inclusive) in Fig. 4 where position A_1 corresponds to A in Fig. 2. By the time the blade has reached A_3, it has zero incidence (like blade B in Fig. 2), while at A_5 it has a negative incidence (like blade C in Fig. 2) and at position A, zero incidence again (like blade D in Fig. 2).

Similarly, if the control point N is moved to the right of point O (not illustrated) there is a net thrust propelling the craft backwards, while if N is moved forward (Fig. 5), the craft moves to starboard. If N is moved aft, the craft moves to port (not illustrated). When N takes up some intermediate position (Fig. 6) the net thrust propels the ship in a direction normal to the line ON, which is indicated by the thrust line.

The propellers are controlled from a position midway between them, to a design by Bloctube Controls Limited, Aylesbury, Buckinghamshire. The control pedestal houses two steering wheels, one for each propeller, the interconnection from the steering wheels to the operating lever on each of the propellers being by push-pull rods. In the control pedestal there is also a thrust lever, interconnected to a lever on each propeller, again by push-pull rods. The Voith propeller is always rotating at a constant speed, and the speed of the boat is controlled by changing the angle of pitch of the blades by the thrust lever in the control pedestal. The direction of the boat is determined by the angle at which the thrust is operating.

Fig. 1 (Right) The motor car ferry MV "Freshwater" which operates between Lymington and Yarmouth, Isle of Wight.

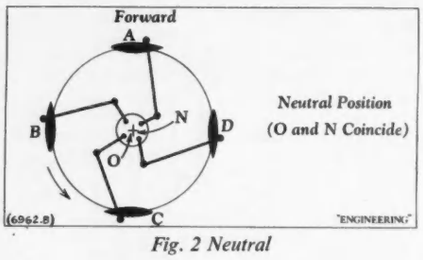


Fig. 2 Neutral

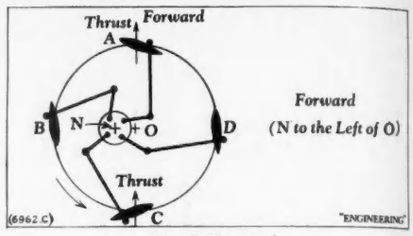


Fig. 3 Forward

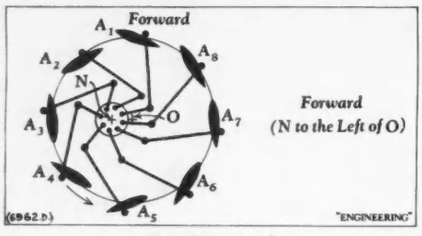


Fig. 4 Forward

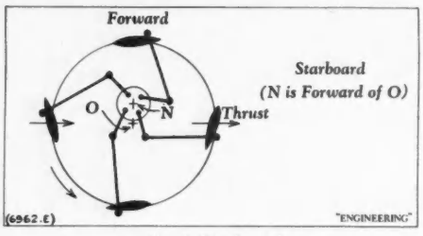


Fig. 5 Starboard

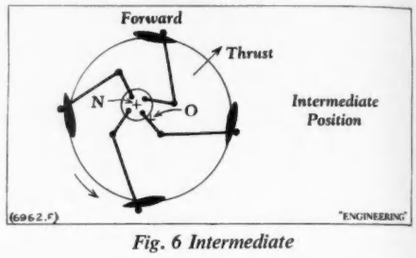


Fig. 6 Intermediate

Damper to offset Earthquake Shocks

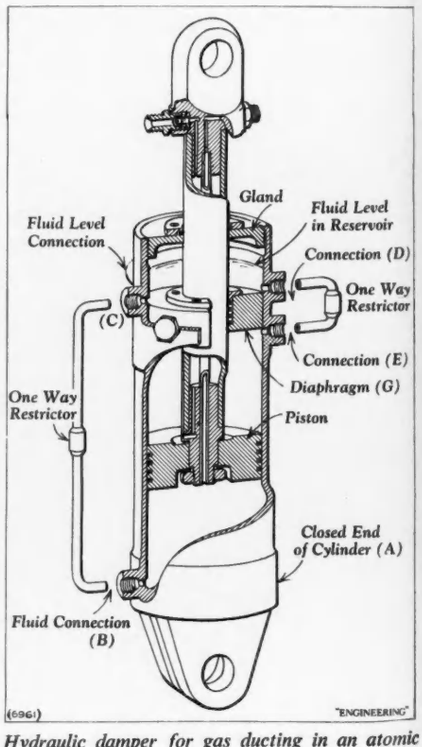
Electro-Hydraulics Limited, Warrington, regard as highly important the design and production of hydraulic units for the protection of structures and relative components from the damaging effects of violent shock or vibration. Research has established that the failure rate of structures which operate under protected conditions is about one-fifteenth of those subject to unprotected conditions.

An application of particular interest has arisen from the requirements for damping severe shocks (such as arise from earthquakes) on the gas ducting of atomic power stations. The utmost reliability is demanded of these units, which in some cases cannot be approached during the life of the power station, but in which the fluid must be changed from time to time. A damper to meet these requirements is described here. The closed end of the cylinder (A) which is mounted in a vertical position, is formed with an integral forked lug for attachment purposes and five bosses for fluid connections.

Moving axially within the cylinder is a piston secured to a piston rod which passes through a diaphragm (G), which divides the cylinder to form a reservoir and damper chamber. Sealing rings are fitted between diaphragm and piston rod, and gland and piston rod. When the piston moves down the cylinder, the fluid displaced passes through the fluid connection (B), the one-way restrictor, and subsequently via (C) to the reservoir. The fluid from the reservoir will at the same time be drawn unrestricted through connection (D) into connection (E) of the damper. Movement of the piston in the opposite direction reverses this flow sequence.

The one-way restrictors limit the travel of the piston in the event of a sudden movement; they offer negligible resistance during a slower movement. Longitudinal drillings in the piston rod permit the passage of fluid through non-return valves to both the upper and lower face of the piston during recharging of the unit. Fluid is discharged through the reservoir and out at a fluid level connection.

An advantage of the unit is that recharging does not interfere with operation and that, if it operates while recharging is in process, high pressure from the damper is prevented from reaching the filling lines by the non-return valves. If the damper is mounted in an inaccessible position, it can be recharged remotely.



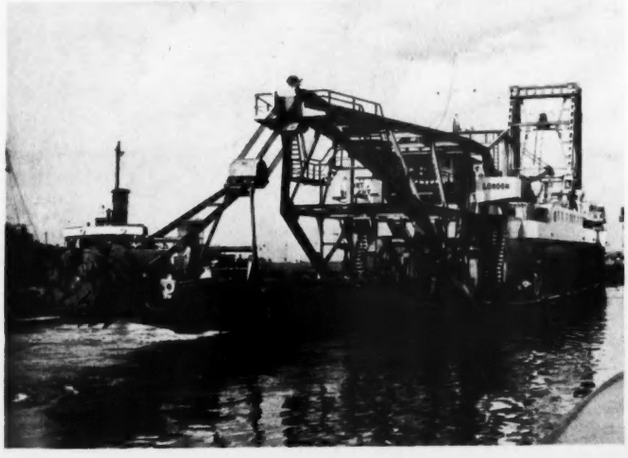
Hydraulic damper for gas ducting in an atomic power station to minimise earthquake shocks.

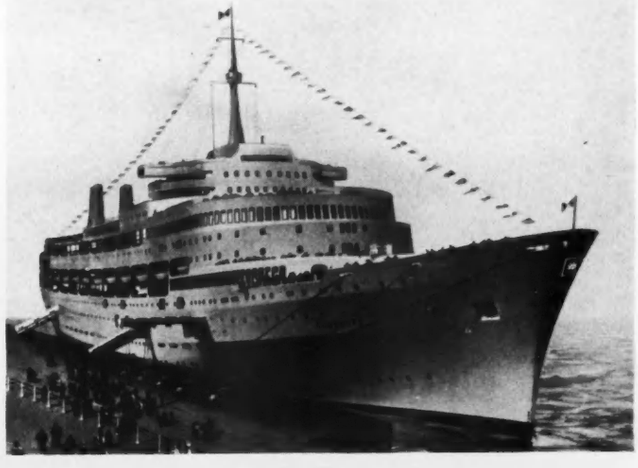
(Left) Transatlantic liner France (Chantiers de l'Atlantique) taking shape at St. Nazaire.

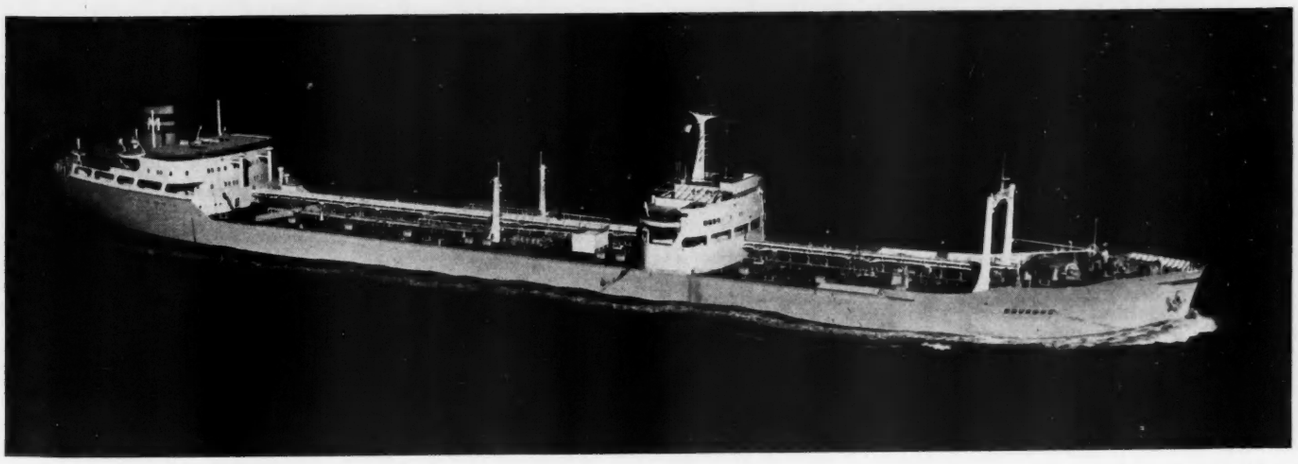
(Right) Former China tea clipper, now maintained by the Cutty Sark Preservation Society.

(Lower left) The Port Sunlight rock cutting dredger (the Westminster Dredging Co.)

(Lower right) The Canberra, under construction by Harland and Wolff for the P & O.







The 41,750 ton tanker Havkong, built by AB Götaverken and delivered in October, is an all-welded vessel, powered by a Parsons turbine of 17,500 s.h.p.

One-Man Machine to Cut, Load and Blow the Crop

The basic consideration in any silage system is maximum output with the minimum of labour. In achieving the optimum result, the speed of unloading the silo is as important as the speed at which the crop is cut and loaded. With this in mind, the David Brown Albion Division has been carrying out field tests with a machine of unusual design which, in terms of reduced labour costs, effortless operation and increased output, sets new standards in silage making and green-feeding.

This new machine, which has been named provisionally the Super Hurricane, will be in prototype form at the Smithfield Show. It has been designed for one man operation throughout and is a self contained unit comprising a moving floor trailer with flail type forage harvester mounted at the rear. The complete unit hitches directly to the tractor and operates as an in-line outfit, driven from the power take-off.

The flail cutter unit is fitted with castor wheels and can be raised and lowered hydraulically. With this unit in the lowered position, cutting and loading are carried out simultaneously in such a way that the crop is fed forward into the trailer via the harvester chute. When the trailer is full, the flail cutter unit is raised clear of the ground hydraulically and the entire outfit is driven to the silage pit, where it is reversed into position for unloading and the flail unit lowered to the ground. A baffle plate in the rotor housing of the flail units is rotated to blank off the chute and provide a rearward exit for the crop. The moving floor mechanism in the trailer is then put into motion and the crop is fed by means of three sets of shredders to the rotating flails, which blow the crop through the rearward opening directly into the silo. The direction of the discharge can be varied by movement of an adjustable deflector plate, enabling the cut crop to be distributed evenly to all parts of the silo without need for spreading by hand.

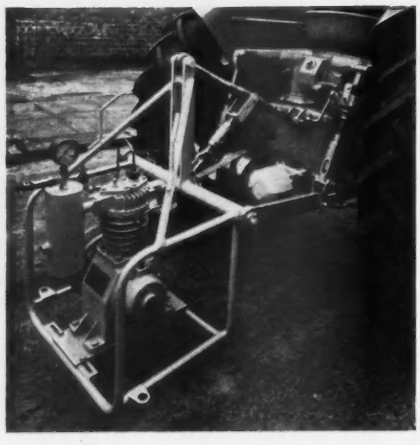
In the design of this outfit, special attention has been paid to the requirements of zero grazing, the practice of which has increased substantially this year in spite of restrictions imposed by the lack of suitable equipment for unloading. A cross conveyor attachment has been designed for fitting to the unit to give direct discharge of the cut crop to the ground or into feeding troughs.

The outfit can, of course, be used for other purposes such as cutting, loading and discharging kale, sugar beet tops and other material which is normally cut and carted away for direct feeding. In addition, it is intended to offer the moving floor trailer unit as a large capacity power take-off driven manure spreader. In this case a suitable auger spreader mechanism will be fitted to the rear of the trailer in lieu of the standard flail cutter unit.

By removing the flail cutter, the self emptying trailer with high sides and cross conveyor attachment becomes a self unloading forage box. Panels in the side or front of the trailer can be removed to allow use with either side or rear delivery forage harvesters.

Tractor Mounted Air Compressor

A tractor mounted air compressor is being shown at the Smithfield Show by Newage (Manchester) Limited, 6 Carlos Place, Grosvenor Square, London, W1.



It has a wide range of applications. Enough power is supplied for all forms of paint and insecticide spraying and the compressor can be used for the operation of pneumatic tools for hedge cutting, pruning and drilling, as well as taking care of maintenance work, such as tyre inflation and greasing.

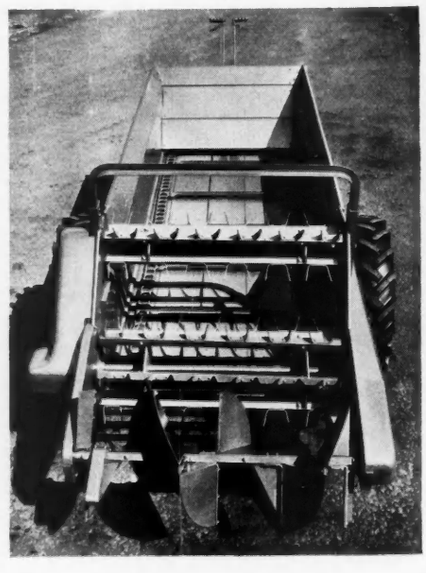
Two models are available, complete with mounting framework, air receiver, belt unloader, safety valves, pressure gauge and belt tensioning device. The complete unit is mounted on the standard linkage at the rear of the tractor and the compressor is driven by a flat endless belt from the right angle pulley drive. Belt tensioning is by simple adjustment and the complete unit can be raised by the tractor hydraulic mechanism for transport without removing the belt.

The compressor is suitable for mounting on the following tractors: Nuffield 3 and 4, Fordson-Major and Fordson-Dexta, Ferguson 35 and 65, David Brown 25, 25D, 900 and 950, International B250, B275 and B450.

Technical Specification—Model A: Pressure 100 lb per sq. in, displacement 24 cu. ft per min, single cylinder, speed 875 r.p.m.

Model B: Pressure 100 lb per sq. in, displacement 42 cu. ft per min, twin cylinder, speed 765 r.p.m.

Also on show will be a range of BMC industrial engines suitably modified for combine harvester variations. These engines include the Newage/BMC 1,500 c.c. low compression head engine operating on vaporising oil for the Massey-Ferguson 735 combine harvester and the Newage/BMC 4,000 c.c. high compression head high powered engine operating on vaporising oil for the Massey-Ferguson 780 and the Allis-Chalmers " Gleaner " combine harvesters.



Improvements to a Manure Spreader

The latest David Brown Albion manure spreader includes several new features designed to improve performance, capacity, durability, safety, and appearance.

Detachable side extensions facilitate low loading and ensure maximum capacity. The preset safety clutch, formerly an extra, is now included in the standard specification. The three-stage spreading auger is dynamically balanced to give smoother operation, and roller bearings are fitted to the land wheels for the same idea.

As with the previous model, the body is of hardwood with glass fibre guards to prevent corrosion. Protective mechanism ensures against damage to the conveyor and shredder from stones, metal or other hidden objects. With a low gear drive to the three-stage spreading mechanism, the danger of wheel slip in adverse ground conditions is eliminated. Five rates of load distribution, ranging from 4 to 20 tons per acre, are provided. A choice of drawbar is available to suit various types of hitch.

Capacities and dimensions:—Box capacity: 65 bushels (about 35 cwt.). Spreading rates (per acre): 1st speed, 4 ton; 2nd, 8 ton; 3rd, 12 ton; 4th, 16 ton; 5th, 20 ton. Overall width 6 ft, length 16 ft 9 in. Dimensions of box: length 9 ft, width 3 ft 6 in, depth 17½ in (22½ in with side extensions). Weight of machine (unladen) 14½ cwt.

When Current Must Not Fail

From hospitals to factories, there are many places where failure of electric current could be troublesome or even, in certain circumstances disastrous. Standby batteries can prevent such an occurrence.

Even in these days of reliable electricity supplies, failures are possible. Plant breakdowns, storms, accidents, many things beyond the control of man, can interrupt electricity supplies to a particular area, to individual premises, or to parts of premises. Such an interruption may be nothing more than a nuisance; on the other hand, it could be dangerous. A lighting failure in the operating theatre of a hospital; in a public hall, where a panic might ensue as a result; or in a factory, where moving machinery could present a hazard to personnel; these are obvious examples of potentially dangerous situations.

Failure of current providing power can be just as dangerous as when lighting only is involved. The load may fall from a crane magnet, components could be thrown off a rotating electro-magnetic chuck, or a ship might fail to answer her helm during a critical manoeuvre if the power went off. There are also many industrial situations in which current failure, though it would not cause personal hazards, might involve loss of or damage to, material being processed, or damage to the plant itself.

Power failure can, however, be guarded against in more than one way, a particularly simple and effective one being the provision of standby batteries. An installation of this type can be completely automatic in operation.

BASIC TYPES

" Nife-Neverfayle " emergency battery equipment, made by Nife Batteries, Redditch, Worcestershire, is designed for three basic circuits, one or other of which meets most normal requirements; variations can, however, be made to suit particular conditions. The basic types of circuits are: the non-maintained, the maintained and the floating type. In the first, the emergency circuit is not normally connected, and only comes into operation, through an automatic switch, when the power fails. The maintained circuit, on the other hand, is normally supplied directly from the mains, or through a step-down transformer at reduced voltage, and an automatic switch transfers it to the battery in the event of mains failure. In the floating circuit the battery supplies the current normally, the load being balanced continuously by the output from a rectifier. On mains failure the battery simply continues to carry the load, no automatic changeover device being needed.

At the heart of the system is the Nife nickel-cadmium alkaline battery, which uses nickel hydroxide as the active material in the positive plates and a mixture of cadmium and iron in the negative. Apart from these materials the battery is almost entirely constructed of steel. A solution of potassium hydrate in water is used as the electrolyte. Important features of the Nife battery are that it has no open circuit losses and does not, therefore, require to be trickle charged; it does not give off corrosive fumes; and it only occupies a floor space equal to about one-third of that required by conventional batteries of the same capacity.

LIGHTING

Any of the basic circuits described can be used for emergency lighting, the floating circuit being particularly applicable for installation where automatic switches are not permitted. The well-known Shakespeare Memorial Theatre, at Stratford-on-Avon, is equipped with a 230 V Nife battery of 168 cells, having a capacity of 215 Ah (amp-hour). This equipment, installed in 1936, is still in operation giving satisfactory service after a period of 23 years. A recent installation, for similar duties, at a new London office block has a 240 V Nife battery of 216 cells, with a capacity of 120 Ah at the 5 hour rate of discharge, and is capable of supplying 9 kW for 3 hours.

Light and power can be supplied from the same emergency installation. A 100 V Nife battery of 84 cells and 75 Ah capacity provides power up to 15 kW for switch closing duties, 1½ amp for indication, and 30 amp for lighting in the arc furnace shop at Brymbo Steel Works, North Wales. Similarly, at Keadby Power station, near Scunthorpe, a Nife 240 V 440 Ah battery set gives 19 kW for one hour for emergency lights and 108 kW for 20 min for operating oil pump motors.

INDUSTRIAL

Power stations use emergency battery sets to provide power for turbo-generator oil pumps, and there are many industrial applications of a similar nature. At the works of C. A. Parsons and Company Limited, Newcastle upon Tyne, there are three large dynamic balancing machines which take from ½ to 1 hour to run down after the power is cut off. To safeguard the machines, emergency lubrication arrangements have to be made in case the power should fail and stop the lubricating oil pumps. This could have been done by providing elevated oil tanks with gravity feed to the machines, but it was found that the cost of the oil required alone would be greater than that of an oil pumping set.

In the Leamington works of the Lockheed Hydraulic Brake Company Limited, an electro-magnet is used on a crane for lifting steel bars. The power is supplied by a 220V Nife battery set mounted on the crane, together with charging equipment, which cuts in automatically as the battery voltage falls to 190, and cuts out again when the voltage reaches 225.

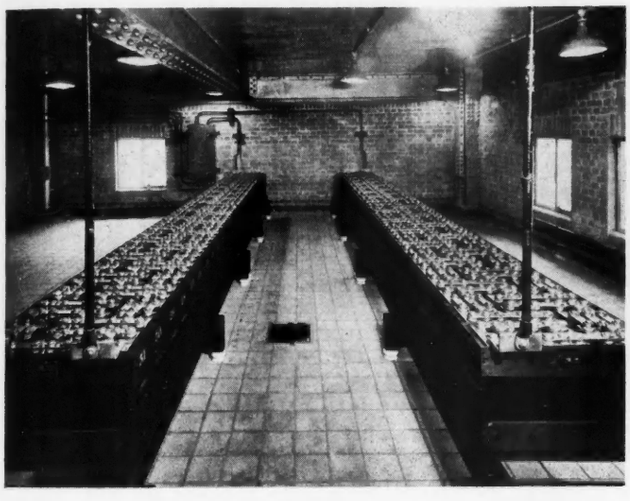
MARINE

International agreements provide for the installation of emergency power equipment in ships. Briefly, the agreements specify that in certain classes of passenger ship a self-contained emergency power source shall be provided, capable of powering emergency lights, navigation lights, watertight doors and other vital equipment for a period of 36 hours. This long period rules out a battery, and a diesel engine is usually installed to carry the emergency load. There is a provision in the agreed regulations, however, that if a generator is installed, there shall also be a battery as a temporary source of power, which comes into operation automatically in the event of failure either of the mains supply or the emergency generator. This battery must be capable of carrying the emergency lighting load for ½ hour and at the same time, of closing the watertight doors if they are electrically operated. In addition, a separate battery is very often employed for starting the diesel generator.

Operation of electric or electro-hydraulic steering gear is also safeguarded by means of emergency batteries, particularly on vessels which normally ply in difficult or congested waters, and where failure at a critical time might result in damage to, or even loss of, the ship.

PORTABLE

Batteries can be easily adapted for use in hand lamps, their stability and lack of self-discharge rendering them reliable and guaranteeing operation even after a long period of idleness. They are fitted to lamps of varying types, ranging from simple hand-lamps of 10 hour capacity to dual filament searchlight hand-lamps of 3 hour main filament capacity and 20 hours on the reserve filament. Lamps with a separate battery and headpiece, to be worn on a safety helmet, cater for applications where both hands are needed, and types are available to meet the requirements for safety.



The small, compact layout of Nife standby batteries is shown by this 240V, 440 Ah set at Keadby Power Station.

These bar lifting magnets at Lockheed works are safeguarded against current failure by a battery set mounted on the crane.

Doubling Lamp Output

A new machine for making the pinch seal of an incandescent lamp, the basic stage in lamp manufacture, has been developed by the Osram Lamp Works of the General Electric Company Limited. The machine is now undergoing trials at a speed of 3,500 pinches per hour, and is probably the fastest machine in the world for performing this type of operation. It is reported to be capable of still greater speeds. The machine works on the principle of constant uniform flow throughout processing rather than step by step manufacture—a principle new to lamp manufacturing.

A pinch seal comprises four parts. They are a flanged glass tube, a hollow glass stem, which acts both as an exhaust tube and a filament support, and two lead wires with fuses. The filament of the lamp is mounted on to this assembly and is finally sealed into the lamp bulb.

So far, pinch seals have been made by using a turntable or turret. This moves round so that each station on it comes to rest in succession at a given fixed position. Feeding devices, manipulating tools and heating burners are arranged in these positions. A pinch seal assembly therefore moves from one rest position to another round the machine, going through a succession of operations until completed. By using this system, a number of parts can be processed at the same time and several operations can be performed on one machine.

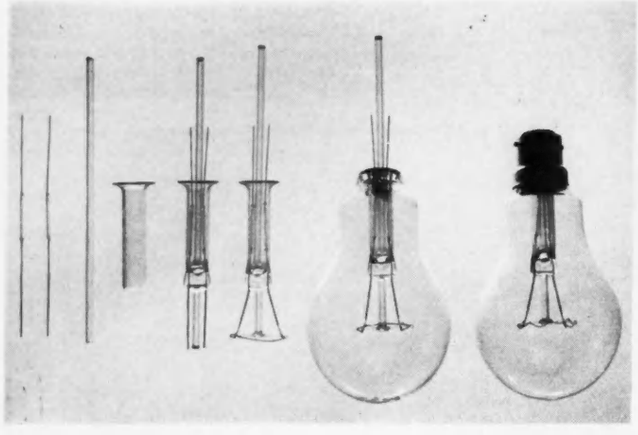
Modern machines of this kind can handle about 1,500 to 1,800 parts per hour but they have limitations which make increases of speed difficult. Frequent stopping and starting requires high acceleration forces which stress the machine highly and call for frequent maintenance. As the machine is speeded up these stresses become exaggerated. It also reduces the length of the rest periods during which the operations are carried out. If these involve heating or cooling there may not be time enough in one rest period to complete the process and more stations may have to be arranged on the turret to allow for this. This means a larger diameter turret will be needed and therefore greater stresses put on the machine, and so on.

The new machine revolves steadily and continuously instead of repeatedly stopping and starting. It cuts out the strains of repeated acceleration and deceleration, the whole revolution can be used for processing and more than one operation can be carried out on the lamp at any given time.

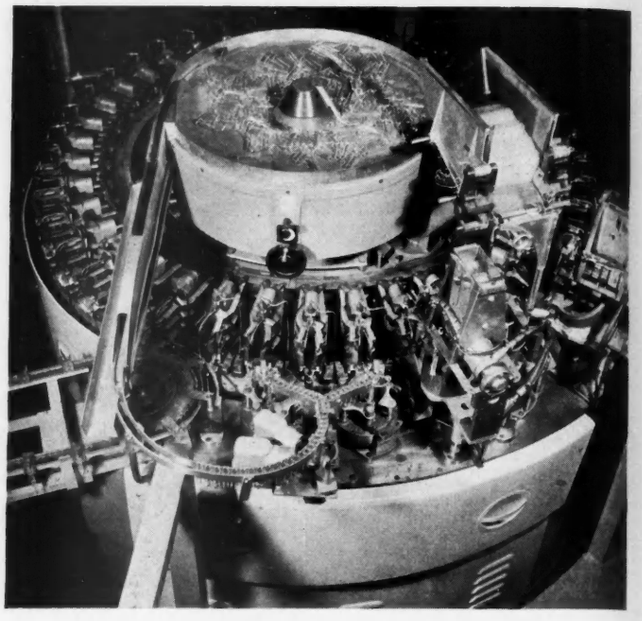
The machine has a rotating turret with 40 work heads, each complete with its set of tools and burners. Five devices round the turret feed the components to the work heads and the completed pinch seal is removed by a small transfer turret. Feeding and take-off are both smooth.

The principle can be applied at much greater speeds than are used at present; speeds which are quite impossible for conventional machines. The machine itself is only the first step in achieving a complete manufacturing group based on the constant flow principle. Other machines using this principle for the subsequent operations such as filament mounting, sealing-in and gas-filling are at the design stage.

(Below) The stages in making a lamp. The new machine assembles the four components on the left into a finished "pinch seal" on the right.



(Right) The top of the pinch machine with the hopper which feeds the flanges down a chute to the working heads. At the bottom left is the take-off conveyor which removes the completed pinch seals.



Lateral Impact Extrusion

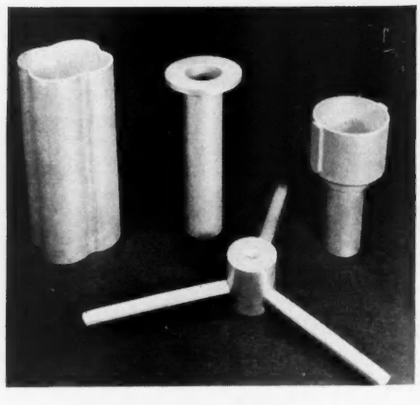
The impact extrusion process has been developed one step further recently to give lateral extrusions. The basic idea is that the billet is hit so that the material, as well as flowing backwards round the punch and forwards into a die, also flows out sideways. The Aluminium Company of America who claim to have conceived the process are reported to have developed the process so that it is now offered for commercial production.

In developing the new technique, Alcoa proved the process by designing a part similar to the hub and spokes or spider of an automobile steering wheel. This part, which is shown in the accompanying illustration, is produced in one operation, cold, from a cylindrical billet.

Impact extrusion has been used for a long time where wrought strength and close tolerances were desired for products with intricate design features. The process is used where strength or tolerance properties, and quality of finished product, exceed the results obtainable from such techniques as drawing, forging or casting. It is now being used frequently for operations that are beyond the abilities of other metalworking methods. These same factors would apply in the lateral impact process. It will permit economical production of parts that combine an intricate hub or core with such lateral extensions as spokes or vanes. Such a part would be free of porosity and brittleness, and would have toughness and high wrought strength throughout.

The products of the various impact extrusion processes in the accompanying illustration. From left to right the examples are: reverse impact, made by metal flow round a punch; forward impact, made by metal flow down into a die; and combination impact, made by metal flow both upward round a punch and down into a die. The lateral impact, illustrated by the "spider," adds the possibility of metal flow outward from the direction of the press stroke.

For competitive reasons, Alcoa have found themselves unable to give any details of the technical aspects of tooling to produce the lateral impact.



Products of the various impact extrusion processes.

Production

Flame Cutting Material 5 ft Thick

The flame cutting of materials between 1,200 mm and 1,600 mm thick (1,000 mm = 39·3 in) was demonstrated recently in Osnabrück in Germany. The demonstration was of an appliance developed by British Oxygen Gases Limited and it was held at the steel works of Klöckner-Werke AG (Georgsmarienwerke). The material was cut using propane as a fuel gas, and the cuts were made horizontally and vertically by one man using relatively simple equipment.

The first cut was made in a vertical cast steel riser 1,200 by 700 mm of material GS52. The depth of the cut was 1,200 mm and it was made in the horizontal plane. For this cut the material was preheated for 3 min and the total cutting time for the 700 mm long cut was 17·5 min. During the preheating period, an oxygen: propane ratio of 3·3:1 was maintained and the consumption of oxygen over this period was 44·2 Nm³/h. During the cutting of the riser 115 Nm³/h of the same gas was consumed. Other data are tabulated in the table.

Setting up the equipment before the cut.

The forged plate after it had been cut.

—	Riser, 1,200 × 700 mm, Cast Steel	Forged Plate, 1,580 mm deep, Heat-treatable Steel
Depth of cut	1,200 mm (horizontal)	1,580 mm (vertical)
Cutting oxygen pressure	1·9 atmospheres	1·9 atmospheres
Preheating oxygen pressure	3·8 atmospheres	3·8 atmospheres
Total oxygen consumption	159·2 Nm³/h	152·5 Nm³/h
Propane pressure	1·05 atmospheres	1·35 atmospheres
Propane consumption	13·4 Nm³/h	15 Nm³/h
Cutting speed	40 mm per min	40 mm per min
Preheating time	3 min	6 min

The second cut in a forged plate was vertical to a depth of 1,580 mm in material GK35 (heat treatable steel). This called for a preheating time of 6 min and a cutting speed of 40 mm per min. Again during preheat the oxygen:propane ratio was 3·3:1, but this time the oxygen consumption amounted to 49·5 Nm³/h. During cutting the oxygen consumption was 103 Nm³/h. More data about this test can again be found in the table.

It is reported that during the second of these two demonstrations, the nozzle was accidentally moved downwards into the workpiece where it remained in contact with the molten metal for some 15 seconds. Over this period no flashback occurred, suggesting that under these conditions the equipment is safe to operate.

Propane was used as the fuel gas in this demonstration because of its peculiar qualities which make it particularly suitable for this purpose. Unlike other gases used in the autogenous process, propane, with its low flame velocity, is a so-called slow burning gas. The low flame velocity not only inhibits flashback, but also promotes the formation of the long flames needed for cutting very thick materials.

In the past the nozzles available have not given the required performance when used with propane. They are blamed for the high rate of oxygen consumption on which accompanied the use of propane when it was introduced some ten years ago. Another difficulty which accompanied the use of propane was the flame lifting due to the high rate of gas flow. Special nozzles have been produced by the British Oxygen Company which overcome these difficulties and which have turned oxy-propane cutting into a usable process.

The demonstration was arranged by Deutsche Shell AG.

AIR COOLED OIL REFINERY

An oil refinery which can cope with 2,000,000 tons of crude oil per year has been built for the Irish Refining Company, at Whitegate, 23 miles from Cork. Building of the refinery, which was opened on 22 September, began in the autumn of 1957 and the plant has the distinction of being the first entirely air-cooled refinery in Europe. When in full production, the plant will supply nearly all of Eire's refined oil requirements which include motor spirit, aviation jet fuel, vaporising oil, diesel and industrial fuels, and liquid petroleum gases.

The crude oil from the Middle East is pumped from the tankers berthing at the refinery's marine terminal into five storage tanks situated on Corkbeg Island, which is linked by a causeway to the refinery. The storage tanks, each holding 6,280,000 gallons of oil, are reported to be among the largest in Europe.

Marketing

Promoting Instrument Sales

The sale of scientific instruments has become highly competitive. One of the leading makers, Griffin and George Limited, have just taken the first step in the improvement of their national coverage by opening a branch office at Newcastle upon Tyne. The opening was supported by two exhibitions of the company's range of instruments in Newcastle and in Middlesbrough.

The theme of these exhibitions was "Instruments for Education, Research and Development." They illustrated the work being done by a subsidiary, Griffin and George (Research and Development) Limited, under the direction of Dr. A. J. P. Martin, F.R.S., a Nobel Prize winner in 1952, who placed considerable emphasis on technical service to users and to meet "the numerous new demands created daily by the accelerating progress in science." The anticipation of the future requirements of scientists is the strength of the company and indeed of the industry as a whole.

Cutting Cat Costs

Industry is now committed to substantial price reductions along a very wide front. From time to time we have commented in these columns on reductions which have followed the break up of trade association agreements in accordance with the implementation of the Restrictive Practices Act. There is now growing evidence that the new capacity built over the past two or three years in many sectors of manufacturing industry will allow price reductions. Many more reductions would have been made already had not the trade recession coincided with the commissioning of so much new capacity.

Among recent announcements is one by Smith's Aviation Division of S. Smith and Sons (England) Limited. A new price structure has been announced covering synchros and small motors which offers quantity reductions ranging from 10 to 50 per cent depending on the number and type ordered. "Increased emphasis on the sales of these components," say the company, "has enabled Smiths to adopt more economical production methods resulting in a reduction of manufacturing costs." Courtaulds and Shemstrand, the two leading makers of acrylic fibres, announced price reductions ranging from 4 to 28 per cent. The price of "Courtelle" in 3, 4½ and 6 denier is reduced from 100*d* to 96*d* per lb and a special quality will be offered in course deniers at 78*d* per lb. Courtaulds intend to double their capacity for this fibre at their finishing factory by early 1969. Other price cuts concerned solvents made by the Distillers Company. Their acetate ester solvents used for paints and lacquers, pharmacauticals, adhesives and synthetic fibres are affected.

In the "animal consumer" field, Petfoods Limited (a subsidiary of Mars) have reduced the price of their tinned cat food, Kit-E-Kat from 9*d* to 7½*d* a tin which, they say, will bring down the cost of feeding the country's 5 million cats by over £1 million. This cut also follows increased sales and higher productivity.

Cheaper Air Freight

Air freight rates over the Atlantic have been reduced substantially by KLM, Royal Dutch Airlines. General cargo rates are down by 35 per cent on shipments of over 500 kg. In order to encourage volume traffic KLM are making reductions between 30 and 40 per cent on their commodity rates. Among goods which will benefit from the lower rates, if transported in bulk, will be textiles (excluding clothing), leather goods, vehicle parts and electric and precision apparatus.

Future Sales?

Computer manufacture and use in Britain is being studied by a West German mission whose members represent a very wide cross-section of academic and industrial interest.

The companies to be visited by the mission are Ferranti, English Electric, EMI Electronics, Standard Telephone and Cables, International Computers and Tabulators, AEI at Manchester, Elliott's at Boreham Wood, and the National Cash Register company.

The commercial interests and industries represented in the West German team are coal, steel, chemicals, glass, motors, food distribution, airlines, shipping, insurance and banking. Spread over the five days from 30 November to 4 December, the visit, organised by the Electronic Engineering Association and the Office Appliance and Business Equipment Trades Association, has the cooperation of the Board of Trade and the British Embassy in Bonn.

New Houses for Old

It rather looks, said Mr. Henry Brooke, Minister of Housing, as if the number of houses approved for grants to make essential modernising improvements will be 70,000 this year, double the previous average of 35,000 a year.

The grants are, or were, one of the least pursued and one of the best bargains available to house-owners. Up to £155, subject to the plans being seen and approved before the work begins, it is possible to get a grant of half the cost of putting in a bath or shower, wash-hand-basin, lavatory, hot water supply and food store, where these do not already exist.

Mr. Brooke was speaking at the opening of an exhibition, running until 2 December, at the Building Exhibition, Olympia, which shows photographs and plans of houses which have been modernised by the use of these grants. At the discretion of the local council it is possible for grants up to £400 to be given for larger improvements or conversions. The new form of the grant system was introduced by the House and Purchasing Act passed earlier this year.

The order of preference among house-holders taking up the grants has so far been, first, hot water systems, followed by wash-hand-basins and baths. An even greater increase in the number of grants taken up is expected for next year, the first full year of the new Act.

£3 Million Boilers

The Central Electricity Generating Board are to order two water tube boilers with accessories from John Thompson of Wolverhampton at a cost of £3 million each.

These are among the largest single units yet ordered by the CEGB and they are for the coal-fired 350 MW units at the Drakelow C power station, Derbyshire. With an evaporation of 2,450,000 lb an hour, each boiler will have a re-heat temperature of 1,055° F, a final steam temperature of the same figure and a working pressure of 2,400 lb per sq. in.

Further afield, the John Thompson group are opening a new branch office, in Buenos Aires, Argentina. Mr. R. J. Horlock, for 11 years Thompson's contracts engineer in Calcutta, will be going out from this country to manage the new office.

At Home

Sink Relief

The picture of Father in his apron standing at the sink has been a longstanding joke—but not for Father. Since in the modern version laziness is the father of invention, what more natural than that engineers should have produced machines for washing the dirty crockery?

Dishwashing machines, like so many other items of domestic equipment, have been slow in catching on in this country, for a reason not entirely separated from the high cost of most of them. A little elbow grease has been much cheaper and anyhow the bother of fitting all the various plates and cups into the respective slots was classed as a fag. But progress is being made and there are now some half dozen makes on sale in England.

The Dishlex Automaid is a large machine for fixing in a permanent position. Loading is from the top, the lower tray holding plates, bowls, and cutlery, and the upper cups, saucers, and

The Colston dishwasher is notable for its small size and portability.

glasses. A permanent connection to a water supply is required, preferably hot, though a 2½ kW heater is incorporated, set to a temperature of 180° F. The cycle is fully automatic and consists of a wash and two rinses, each using one gallon of water. The time for the cycle is variable from 6 minutes upwards.

The machine has a capacity for 20 assorted large plates; 4 small bowls; 30 pieces of cutlery; 14 cups or glasses; and 14 saucers or small plates. Alternatively it can be filled with saucepans, milk bottles or kitchen utensils. Power is supplied by a ¼ h.p. electric motor so that the total consumption of the machine is 3 kW. The cabinet measures 24 in wide by 26 in deep by 36 in high; with the lid raised the height is increased to 56½ in.

The Swanmaid differs from the previous machine in that the crockery is loaded from the front. A door lets down and trays slide out on runners. Again the cycle is fully automatic, starting when the button is pressed and the door closed. The water is heated by a 3 kW element to 180° F and the wash begins. This is followed by two hot-water rinses, the whole cleaning cycle taking about 15 minutes. The dishes can then be left to drain and dry in the machine. Water consumption is three gallons per cycle and it is preferable to have the machine permanently plumbed to a static hot water supply with a constant low pressure head.

Other machines now on the market are the Adamatic, the Summit (of Continental manufacture) and the Kenwood. It is reported also that Modern Equipment Company are proposing to enter the field shortly with a machine that is said to operate on an entirely different principle and to come more within the price range of most people.

The most recent machine to reach the market is the Colston, details of which were released in November. Two main features stand out at once: the small size and its portability. Unlike the two machines already described the Colston does not have to be fixed permanently in one place. Its water connections consist of two lengths of hose, one for supply and one for draining. The whole "works" have been compressed into a cabinet measuring 17 in deep by 21 in wide by 24 in high. It will stand conveniently on a draining board.

As in the Swanmaid, loading is from the front. There are two trays both of which have the metalwork covered with plastic material. On the lower are placed the plates—there is room for 12 large and 12 small—and also the spoons and forks. The upper tray takes the cups or glasses (again there is room for 12) and the knives.

Between the two trays is the jet accelerator, a cylinder that revolves at high speed and through holes in which the washing water passes. There are two nylon filters in the water circuit; a coarse one above the pump intake to trap the larger pieces of debris, and a fine one within the accelerator to prevent the jets getting clogged. Either can be removed for cleaning in a matter of moments.

The cycle consists of a hot water wash followed by two rinses and then drying in a stream of hot air. Either hot or cold water can be fed to the machine as it is fitted with a 2½ kW heater element. Naturally the cycle is quicker when hot water is supplied as the heating period is reduced. Starting from cold, the total time taken till the dishes are fully dry is about 30 minutes. A special detergent is made by the firm which is said to reduce foaming but to improve cleaning, and an additive "Rinshine" contained in a tank in the machine gives a very high polish to the dried items.

An attractive method of mounting the Colston is on a trolley. It is suggested that then it can be wheeled into the dining room and stacked there with the plates as they are removed from the table. Wheeled out to the kitchen, the hoses can be connected up, the mains lead plugged in and the cycle started. The party can then retire knowing that the washing up will be done.

Alas that none of these machines seems to cater for the burnt porridge saucepan! But even here there is hope. The Simsave is an electrically driven scourer that can be mounted above the sink, either on the wall or from the ceiling, and it is said that the bristles will get right into all the corners.

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